

## REMARKS

In view of the following remarks, reconsideration and allowance of this patent application is earnestly solicited. Claims 1 and 3-16 are pending, and have not been further amended. Claims 1, 4 and 16 are the independent claims.

In the Final Office Action -- essentially identical to the previous Office Action -- claims 1 and 3-16 stand rejected under 35 U.S.C. §103(a) as unpatentable over Muzslay (U.S. 4,959,027) in view of Ogawa (U.S. 5,605,475). Applicants respectfully traverse, as set forth below.

As discussed in previous submissions and in at least two Examiner interviews, and as clearly described in the present application, Applicants' invention is directed to embodiments of a pressure-tight contact device. Such a device can, for example, allow electrical connections (from the outside) to a motor that is sealed inside a pressure tight enclosure, without having to break the pressure-tight seal.

The device includes an insulator extending through and sealed relative to a pressure-tight housing, and one or more contact pins are retained in and extend through the insulator and are sealed relative to the insulator. A connector shell is positioned on the insulator, sealed relative to the insulator and removably affixed to the insulator to form part of the contact device. The connector shell includes a terminal socket for engaging a separate mating connector attached to an electric connecting cable. One or more contact tabs are disposed in the connector shell in secure electrical contact with the contact pin(s) and extend into the terminal socket to engage the mating connector. The connector shell is one of a set of interchangeable connector shells having different configurations for mating with different, corresponding plugs.

Because the motor or other enclosed device is inaccessible to a user, and because there was inventive insight that an enclosed device may need to be powered by various electrical sources in different locales, over many years, a mechanism was provided to allow multiple types of plugs to connect to the contact pin(s) by means of various corresponding connector shells. The connector shells (7) thus act as “middlemen” between (i) the fixed contact pin(s) (14) protruding from within the sealed pressurized housing (1) through the insulator (2) on the one hand, and (ii) the plugs connecting to contact tab(s) (6) in terminal socket (28) on the other.

At any one time, multiple connector shells can be interchangeably affixed to the housing (1), facilitating ready mating with various plugs.

The Muzslay patent is in stark contrast to Applicants’ claimed invention. Muzslay is a retrofit solution. Muzslay describes a fuel injector adapter for permanent mounting on a *straight* fuel injector so as to accommodate a harness connector that is specifically designed for an *inclined* fuel injector. That is, Muzslay describes a single adapter configuration having a singular purpose -- to allow an inclined-type connector to be permanently and exclusively mounted on a straight-type fuel injector. *See* Muzslay at Abstract; 1:5-20; 4:24-28; and Figs. 2 and 3. Straight fuel injectors have narrowly spaced terminals, and inclined type fuel injectors have wider spaced terminals. Because, as indicated in Muzslay at 1:5-20, fuel injectors come in only one of two possible configurations -- either a straight, narrow spaced type or a 45° inclined wider spaced type -- and because the problem Muzslay seeks to address involves mating an inclined harness connector with a straight-type fuel injector, the adapter of Muzslay has only a single configuration. Providing anything but a single configuration would be superfluous, as Muzslay interfaces between only the incompatible configurations presented by a straight-narrow spaced fuel injector and an inclined-wider spaced harness.

This presents at least two fundamental differences between Muzslay and Applicants' claimed invention which fatally undercuts Muzslay's value as a reference.

First, Muzslay does not contemplate, and accordingly does not teach or support, an adapter that is one of a set of interchangeable adapters designed to mate with different connectors. The Final Office Action states:

[j]ust only one connector shell is recited in the claims, not a set of interchangeable connector shells; therefore, the limitations above are readable as calling for selection of the shell from among a set of different type connector shells and such limitations do not define over the Muzslay single shell fixed onto his device.

Final Office Action at 7.

This very statement recognizes that the function of interchangeability patentably distinguishes Applicants' invention over Muzslay! However, the Examiner then contends that Applicants' claim somehow does not recite this feature. This is logically inconsistent, and simply incorrect. Respectfully, Applicants disagree. Independent claims 1 and 16 affirmatively recite that the connector shell is one of a set of interchangeable connector shells, where each connector shell has a different terminal socket configuration suitable for engaging a corresponding different mating connector having a corresponding mating configuration. The claim language clearly sets forth a specific property of the connector shell – its being one of a set of interchangeable connector shells – that is simply not to be found or suggested in Muzslay or any other reference cited by the Examiner. Given the contrasting single configuration of Muzslay, there would be no need to remove and interchange the adapter with a differently configured adapter. The Muzslay adapter is not one of a set of interchangeable adapters – it is the only possible adapter to mate the straight fuel injector with the inclined harness. Applicants' invention patentably distinguishes over Muzslay for at least this reason.

Second, as a result of there being only one possible adapter in the fuel injector world, Muzslay does not even contemplate that the fuel injector adapter is removably affixed. In fact, Muzslay teaches away from this feature by consistently expounding that the adapter should be permanently affixed once it is installed on the injector. *See* Muzslay at 1:37-40 and 4:3-18. The Examiner's argument to the contrary on page 7 of the Office Action is inaccurate. There, the Examiner cites to Muzslay at 4:9-18 to support the misplaced contention that the adapter is removably affixed because the adapter and an injector connector end "may be separated from one another at some time before tines are deformed to hold them in place." Yes, but entirely irrelevant. The "separation" is part of the permanent affixation process. First the adapter and the fuel injector must be brought into physical proximity before they can be attached. The "separation" is a partial snapshot, frozen in time, of an interim step in the continuous permanent mounting process taught in Muzslay. The Examiner's citation, which is applied out of context, provides for an intervening step midway through the process of permanently mounting the adapter (it is analogous to taking a series of high speed photographs of a galloping horse and then abstracting one frame showing all of the horse's hoofs in mid-air to "teach" that a horse has a "possible state" in which it can fly). Reading Muzslay at 4:3-23 in its entirety, the end result is still a permanently mounted adapter which implements the stated purpose of a permanently installed adapter. Given the unitary possible configuration of the Muzslay adapter, permanently affixing the adapter is desired as there is no possibility of removing and interchanging the adapter with one of an ersatz set of differently configured adapters, corresponding to a similar set of differently configured harnesses. No such set exists, and no such interchangeability is even contemplated in Muzslay. Because the Muzslay adapter is not removably affixed, Applicants' invention patentably distinguishes over Muzslay.

As previously submitted, numerous federal court decisions have interpreted “removably affixed” claim terms to mean easily removable and interchangeable, rejecting the very same type of untenable interpretation of the term propounded by the Examiners here. *See, e.g., Bengis v. World Wide Packaging, Inc.*, No. 04-5354 (E.D.N.Y. June 22, 2006) (opinion and order granting partial summary judgment). In addition, numerous patents utilize “removably affixed” or similar claim terms to distinguish between elements that are easily removable and interchangeable from elements that are permanently held in place. *See, e.g.*, U.S. Patent No. 7,134,368; U.S. Patent No. 6,988,561; U.S. Patent No. 6,425,307; U.S. Patent No. 6,318,476; U.S. Patent No. 6,009,779. Applicants have addressed these patents in detail in the immediately previous Office Action Response, and see no need to repeat this analysis here.

However, to drive all the foregoing home, Applicants additionally refer the Examiner to Chernoff et al. U.S. Patent No. 7,292,992 (see attached Exhibit I). The claimed Chernoff invention is directed to an automobile with a chassis and an “interchangeable vehicle body.” The claim shares a similar structure with independent claim 1 of Applicants’ present application:

1. A method of conducting a vehicle business transaction with a customer, comprising:

granting possession of a common vehicle chassis having a standardized body-attachment interface to the customer in a first financial transaction for consideration; and

granting possession of an **interchangeable vehicle body** to the customer in a second financial transaction for consideration independently of the common vehicle chassis, the **interchangeable vehicle body selected from a maintained inventory of interchangeable vehicle bodies** each having a common base with a standardized chassis attachment interface that is matable with the standardized body-attachment interface of the common chassis.

Chernoff at 22:13-28 (emphasis added).

Clearly if an “interchangeable vehicle body” were taught by the fact that, in a typical automobile, say a Ford, a vehicle chassis and a body being permanently affixed to it happen to be – during the few moments in time that someone is attaching them on the assembly line – physically proximate but not yet “permanently affixed”, this patented claim would add nothing to the art except selling a car in two installments. In Chernoff, the key feature is the sale of a chassis, and then later selling multiple “interchangeable vehicle bodies.”

Interchangeable means exactly what it says, and does not include, as the Examiner would have it, some metaphysical instant in time where two elements, neither of which is actually interchangeable at all, are in the process of being permanently connected.

Thus, after numerous Office Actions and at least two Examiner interviews, the Examiner has yet to squarely address any of Applicants’ submissions or arguments relating to the plain meaning of “interchangeable.” This, in part, is a result of the Examiner’s tenuous but steadfast reliance on Muzslay. Instead, the Examiner has chosen to wholesale copy and paste versions of prior Office Actions. This denies Applicants a fair and proper examination of the present patent application on its merits, to which Applicants are absolutely entitled.

Ogawa, cited by the Examiner in combination with Muzslay, does not overcome the severe deficiencies of Muzslay as a reference against the claimed invention. Ogawa describes embodiments of an electrical connector in threaded combination with a tube member used for making an electrical connection through a wall. As previously submitted, Ogawa nowhere describes, teaches, or suggests the contact device according to independent claims 1 and 16, comprising a connector shell removably affixed to at least one of an insulator and a housing, the connector shell being one of a set of interchangeable connector shells having different

terminal socket configurations suitable for engaging various corresponding mating connectors having corresponding mating configurations.

Accordingly, independent claims 1 and 16 of the present application recite features and structure nowhere taught or suggested in either or both of the Muzslay and Ogawa references, and, thus, these claims are urged as patentable over these references, taken alone or in combination. Applicants submit that dependent claims 3, 12, 13 and 15 are also allowable for similar reasons. Notice to this effect is earnestly requested.

Dependent claim 14 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Muzslay in view of Ogawa, and further in view of Nakamura. Applicants respectfully traverse.

As previously submitted, Nakamura does not remedy the severe deficiencies of Muzslay and Ogawa as discussed above. Nakamura, cited by the Examiner for its disclosure of a plurality of projections from at least one contact pin, describes embodiments of a waterproof connector having a small size due to the reduction of surplus space. Nakamura at Fig. 9. Nakamura nowhere teaches or suggests the contact device according to Applicants' claimed invention comprising an interchangeable connector shell with its plug receiving terminal socket including one or more contact tabs in electrical contact with one or more contact pins extending through the insulator. Notice to the effect that dependent claim 14 is allowable over the cited references is earnestly solicited.

Independent claim 4 and dependent claims 5-7 and 11 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Muzslay in view of Ogawa, and further in view of Devine. First, these claims were previously found to be allowable, and Applicants fail to understand the paradigm shift. Second, Applicants respectfully traverse.

As previously submitted, Devine describes embodiments of a water tight device for connecting and sealing a coaxial transmission line connector with a signal source connector, wherein the device is capable of detecting water leakage into the connector. Devine is cited for its disclosure of an O-ring for sealing the insulator relative to the housing and an O-ring for sealing at least one contact pin relative to the insulator. However, Devine does not overcome the severe deficiencies of Muzslay and Ogawa as discussed above. Devine nowhere teaches or suggests a contact device comprising a removably affixed (interchangeable) connector shell with its plug receiving terminal socket including one or more contact tabs in electrical contact with one or more contact pins extending through the insulator. Indeed, the Examiner has consistently acknowledged this fact when the Examiner allowed claim 4 in prior Office Actions on the merits, including Office Actions wherein Muzslay was known to the Examiner.

Accordingly, independent claim 4 of the present application recites features and structure nowhere found in Muzslay, Ogawa and Devine, and, thus, claim 4 is urged as patentable over these references, whether taken alone or in combination. Dependent claims 5 and 7-11 are also urged as allowable for similar reasons.

Dependent claims 8 and 9 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Muzslay in view of Ogawa and Devine, and further in view of Cady. Applicants traverse.

Cady does not remedy the severe deficiencies of Muzslay, Ogawa and Devine as discussed above. As previously submitted, Cady describes embodiments of an electrical connector for connecting multi-wire coaxial cables including a housing with a cylindrical bore extending through the housing for each wire. When the center conductor of each wire is coupled to a conductive pin that is then inserted into the cylindrical bore, the outer conductive shield of



each wire is coupled with the housing and with the outer conductive shields of all the other wires in the cable. The Examiner cites Cady for its disclosure of a conductive pin having a flared portion, which the Examiner equates to nose members of a contact tab. The Examiner further relies on this flared portion to support the argument that it would have been obvious to one of ordinary skill in the art to crimp the flared portion of the conductive pin. However, Cady nowhere teaches or suggests the contact device according to the present claimed invention comprising the removably affixed (interchangeable) connector shell with its plug receiving terminal socket including one or more contact tabs in electrical contact with one or more contact pins extending through the insulator. Accordingly, Applicants respectfully submit that claims 8 and 9 are allowable over the cited combination of references by virtue of their dependency from claim 4, as well as for the additional features and structures recited therein. Notice to this effect is earnestly requested.

Dependent claim 10 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Muzslay in view of Ogawa and Devine, and further in view of Klemen. Applicants respectfully traverse.

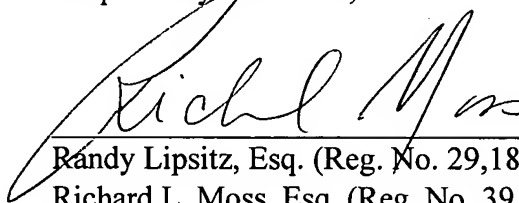
Klemen does not remedy the severe deficiencies of Muzslay, Ogawa and Devine as discussed above. Klemen describes embodiments of an electrical interface connector assembly that blocks the intrusion of undesired substances and elements from the environment. The connector assembly has a generally U-shaped receptacle that is incorporated in a motor housing. A sealing gasket overlies a connector block and is secured by a retainer plate that is fastened to the receptacle by screws. As previously submitted, Klemen nowhere teaches or suggests the contact device according to the present invention comprising the removably affixed (interchangeable) connector shell with its plug receiving terminal socket including one or more

contact tabs in electrical contact with one or more contact pins extending through the insulator. Indeed, Klemen is not even directed at the present invention, as Klemen is concerned with preventing the intrusion of undesired substances and environmental elements past the connector assembly. Screws are used to force the retainer plate down to compress the sealing gasket to create an effective seal such that environmental substances and elements are excluded from the motor housing. Thus, claim 10 is asserted as allowable over the cited combination of references not only by virtue of its dependency from claim 4, but also for the additional features and structure recited therein. Notice to this effect is earnestly requested.

On the basis of the foregoing remarks, Applicants respectfully submit that this application is in condition for immediate allowance, and notice to this effect is respectfully requested. The Examiner is invited to contact Applicants' undersigned attorneys at the telephone number set forth below if it will advance the prosecution of this case.

No fee is believed due with this Response (other than the \$130 fee associated with the Petition for One Month Extension of Time and the \$540 fee associated with the Notice of Appeal, both papers submitted concurrently herewith). Please charge any fee deficiency and credit any overpayment to Deposit Account No. 50-0540.

Respectfully submitted,

A handwritten signature in dark ink, appearing to read "Randy Lipsitz", is written over a horizontal line.

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## **EXHIBIT I**



US007292992B2

(12) **United States Patent**  
**Chernoff et al.**

(10) **Patent No.:** **US 7,292,992 B2**  
(45) **Date of Patent:** **Nov. 6, 2007**

(54) **METHODS OF CONDUCTING VEHICLE  
BUSINESS TRANSACTIONS**

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**D. Shabana**, Ann Arbor, MI (US);  
**Robert Louis Vitale**, Macomb  
Township, MI (US)

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(73) Assignee: **General Motors Corporation**, Detroit,  
MI (US)

(Continued)

(\*) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 824 days.

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(21) Appl. No.: **10/202,396**

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(22) Filed: **Jul. 24, 2002**

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#### Related U.S. Application Data

(Continued)

(60) Provisional application No. 60/314,501, filed on Aug.  
23, 2001, provisional application No. 60/337,994,  
filed on Dec. 7, 2001.

Primary Examiner—James Zurita

(57) **ABSTRACT**

(51) **Int. Cl.**  
**G06Q 30/00** (2006.01)  
(52) **U.S. Cl.** ..... **705/26; 705/37**  
(58) **Field of Classification Search** ..... **705/26**  
See application file for complete search history.

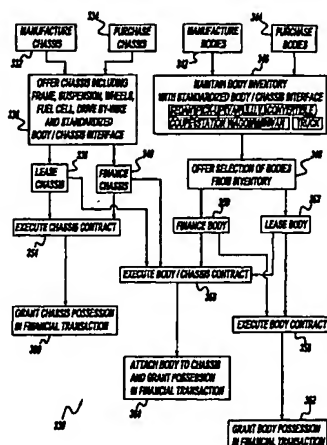
Methods are provided for conducting a vehicle business transaction with a customer. Possession of a vehicle chassis is offered and/or granted to a customer in a first financial transaction for consideration. Possession of a vehicle body for engagement with the chassis is offered and/or granted in a second financial transaction for consideration independently of the vehicle chassis, wherein the chassis and body are separately priced. The body may be selected from an inventory of vehicle bodies each having a chassis attachment interface engageable with the chassis. The chassis may be financed for an extended period of time, such as 20 years, while various bodies are interchanged with the chassis.

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**7 Claims, 27 Drawing Sheets**



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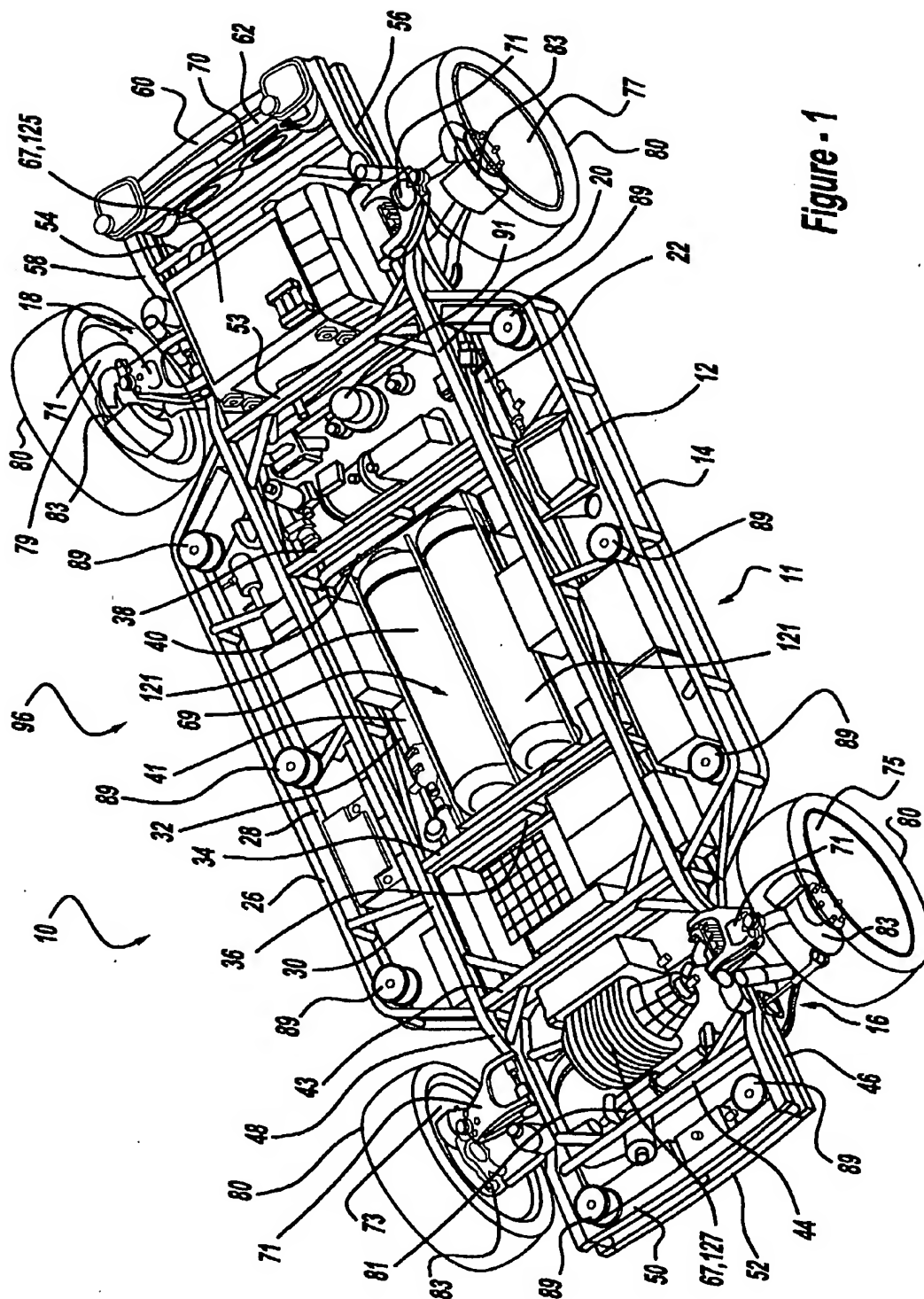


Figure - 1

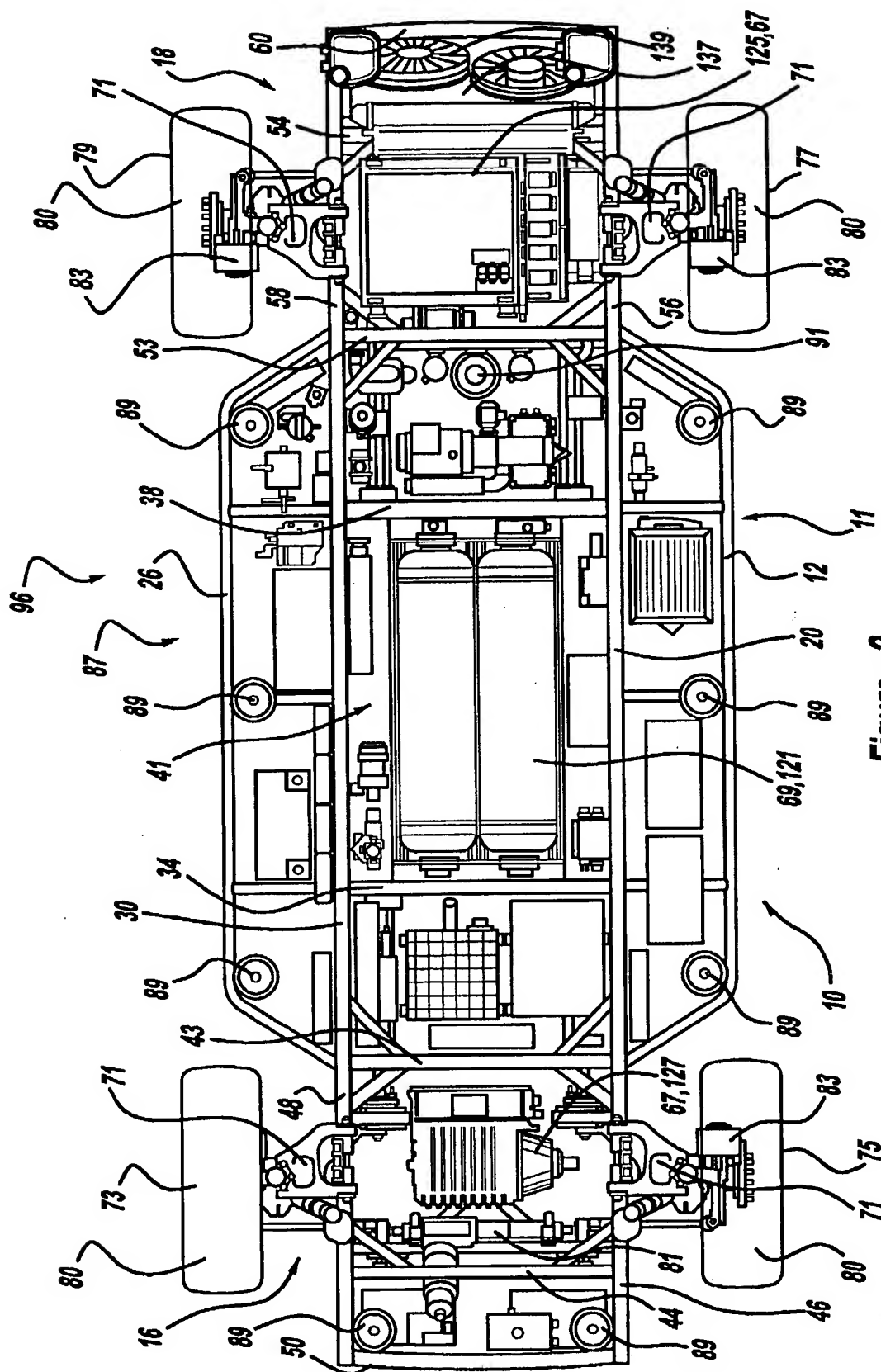


Figure -2

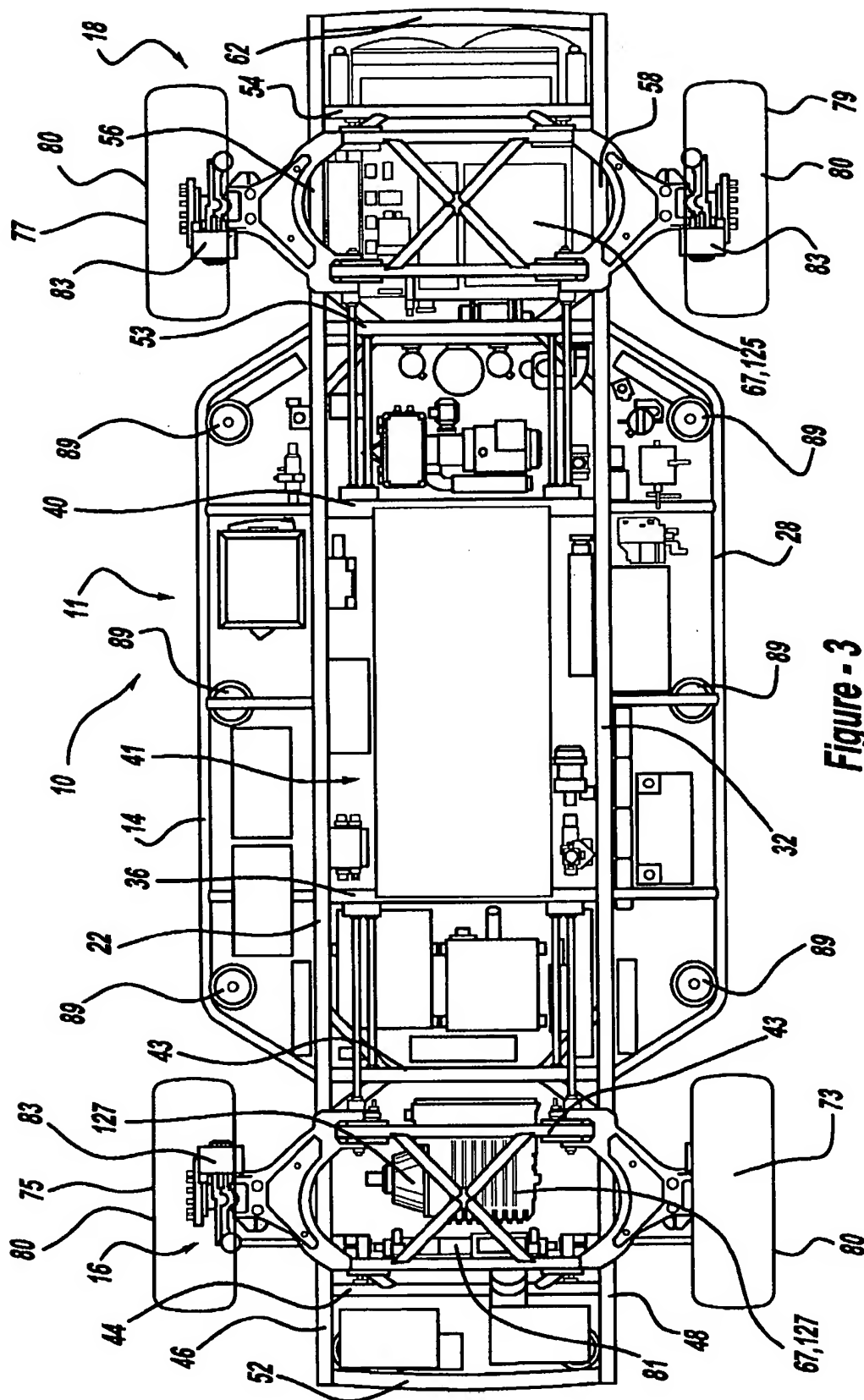


Figure - 3



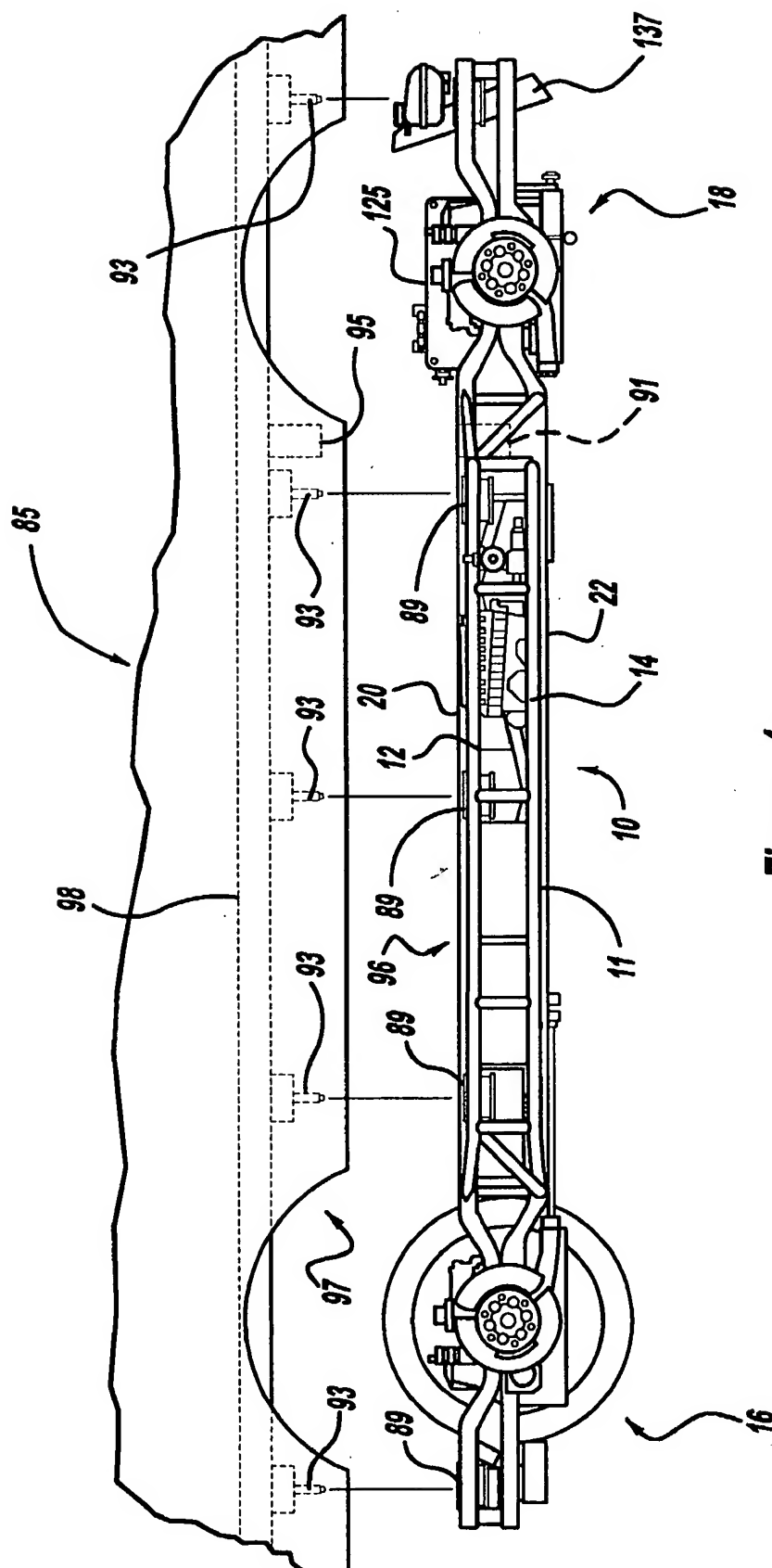


Figure - 4

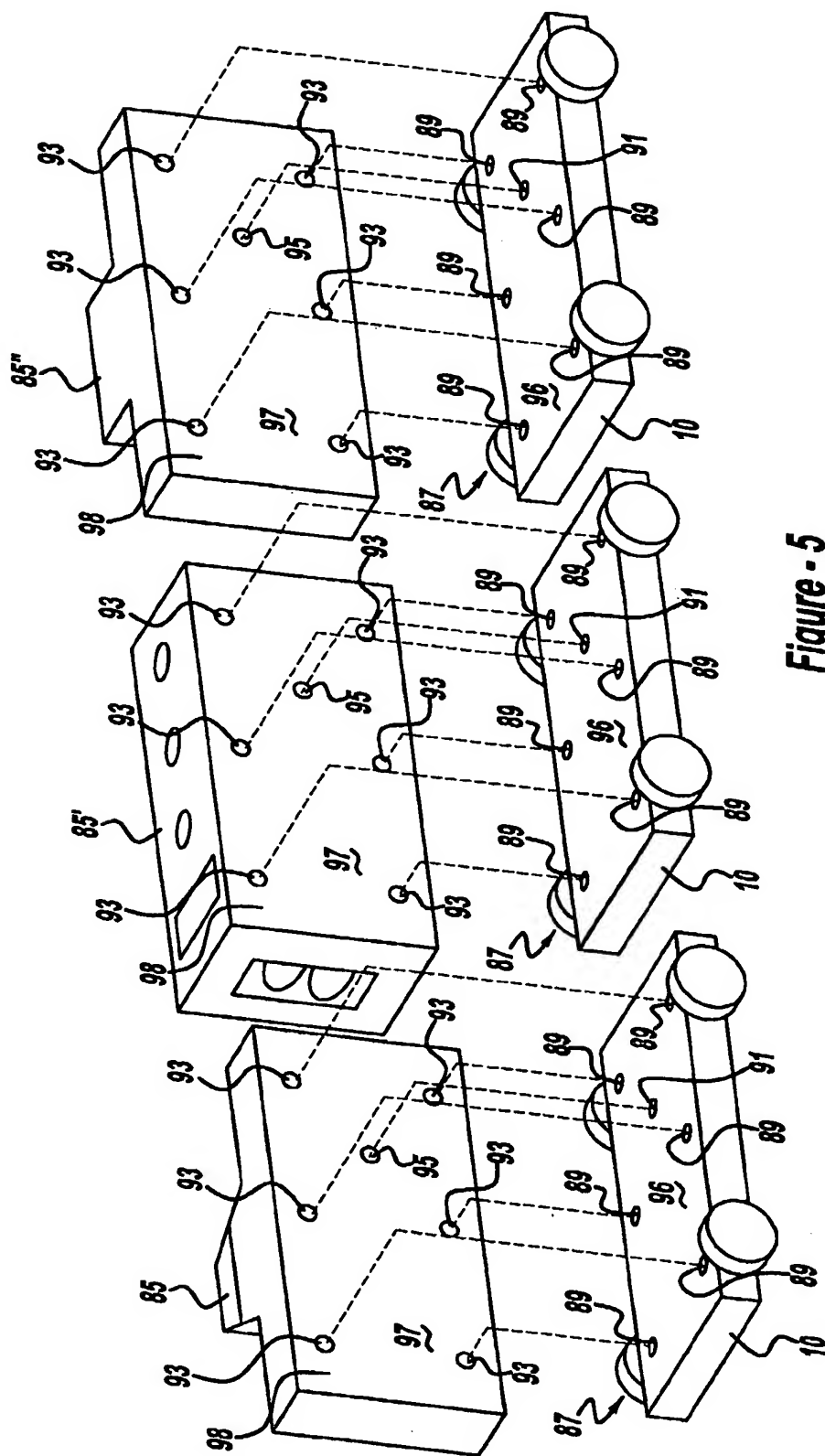


Figure - 5

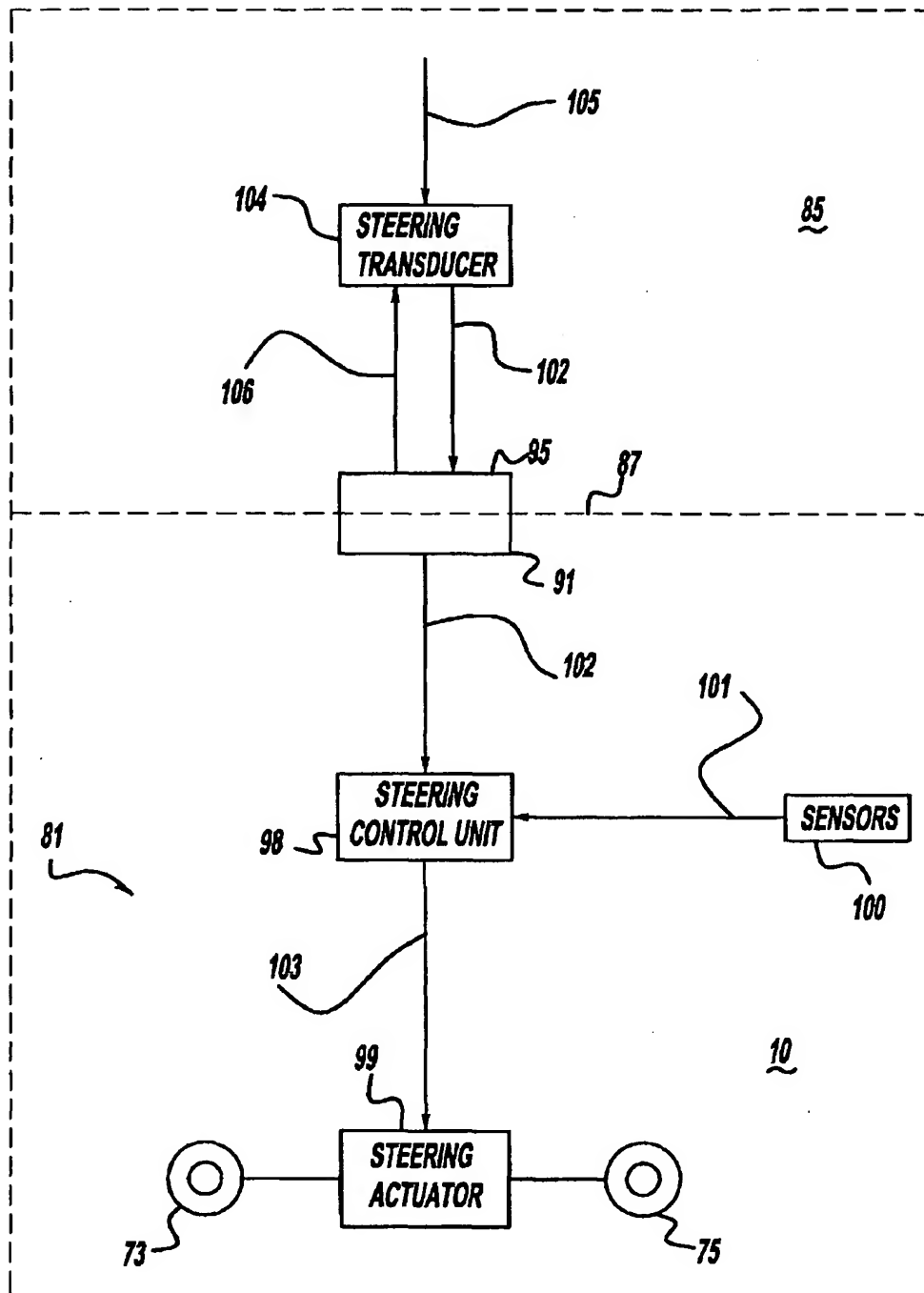
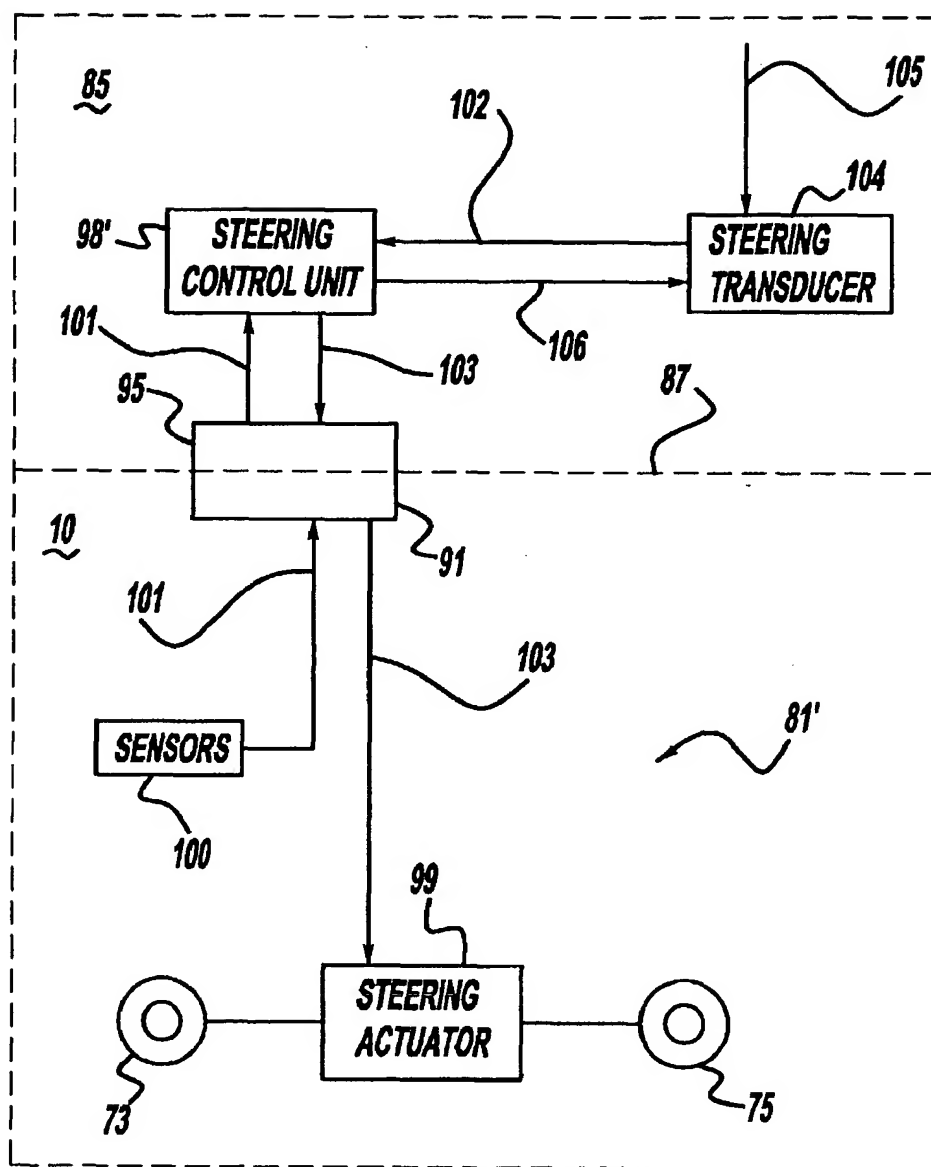
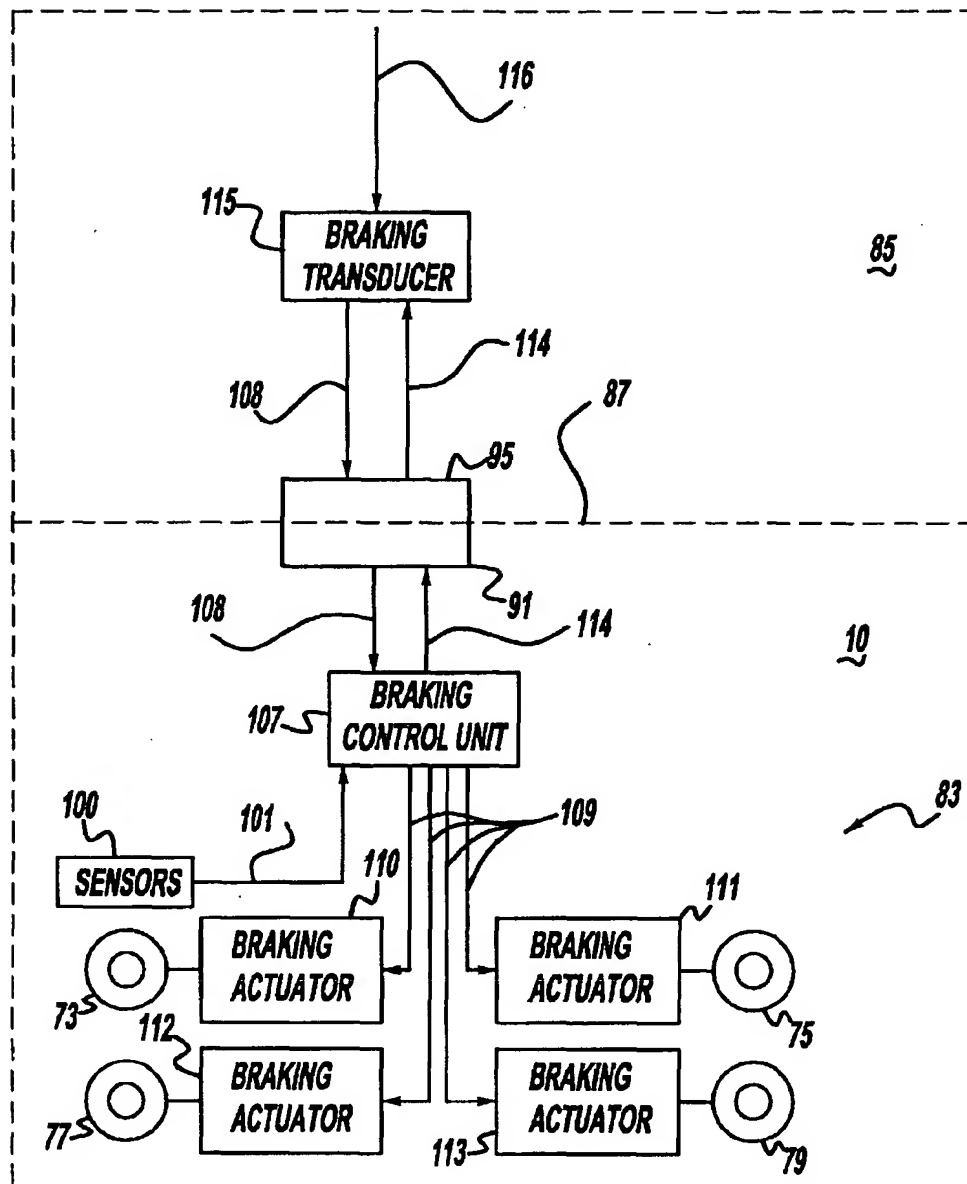


Figure - 6

**Figure - 7**

**Figure - 8**

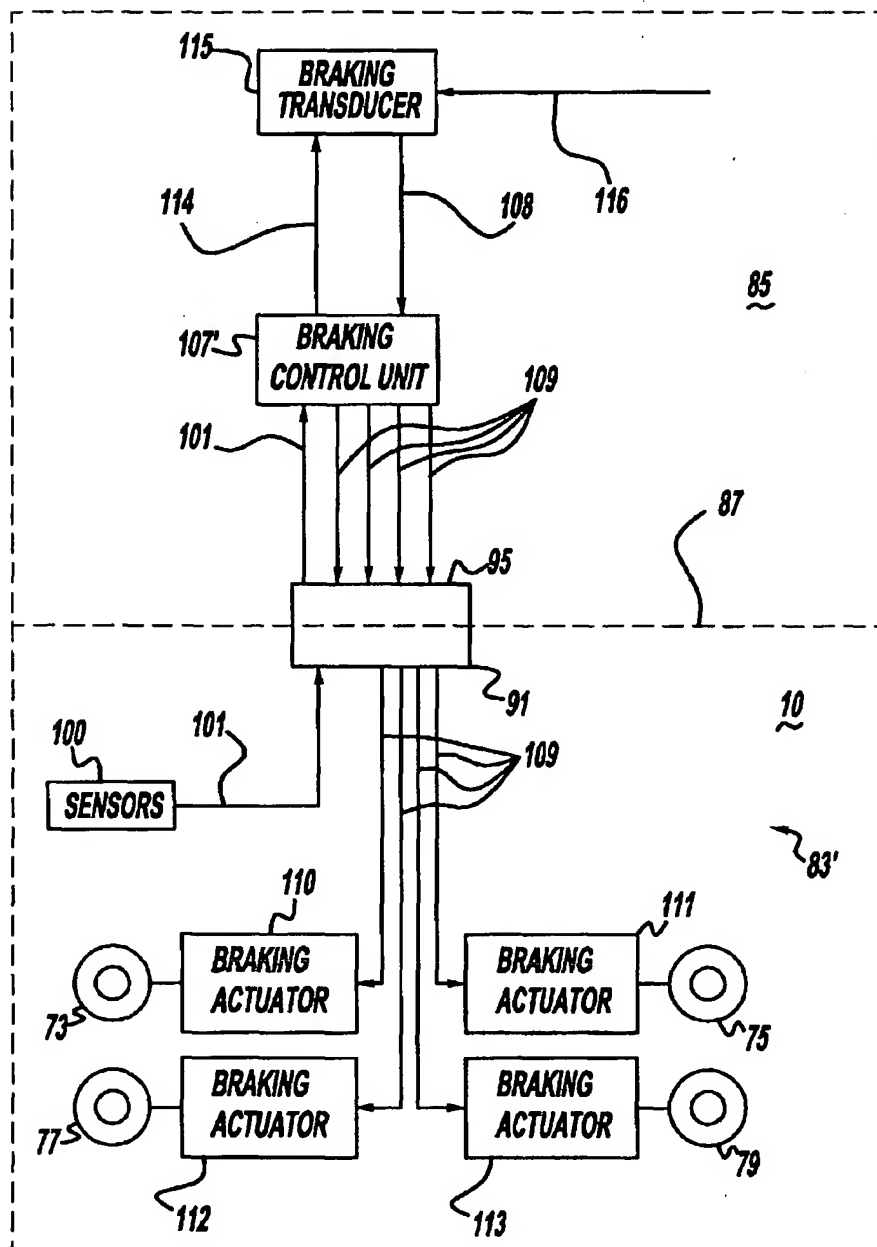
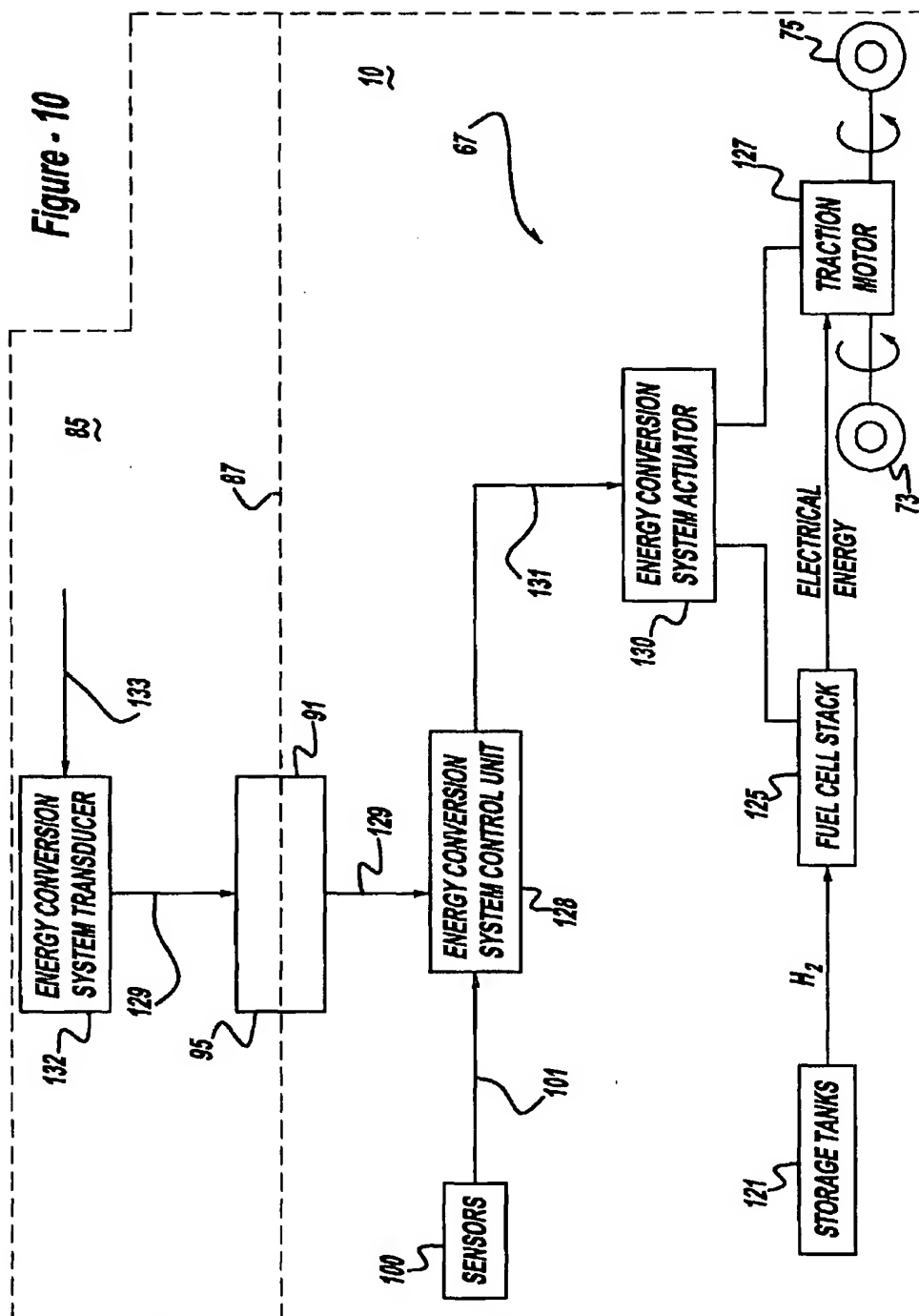
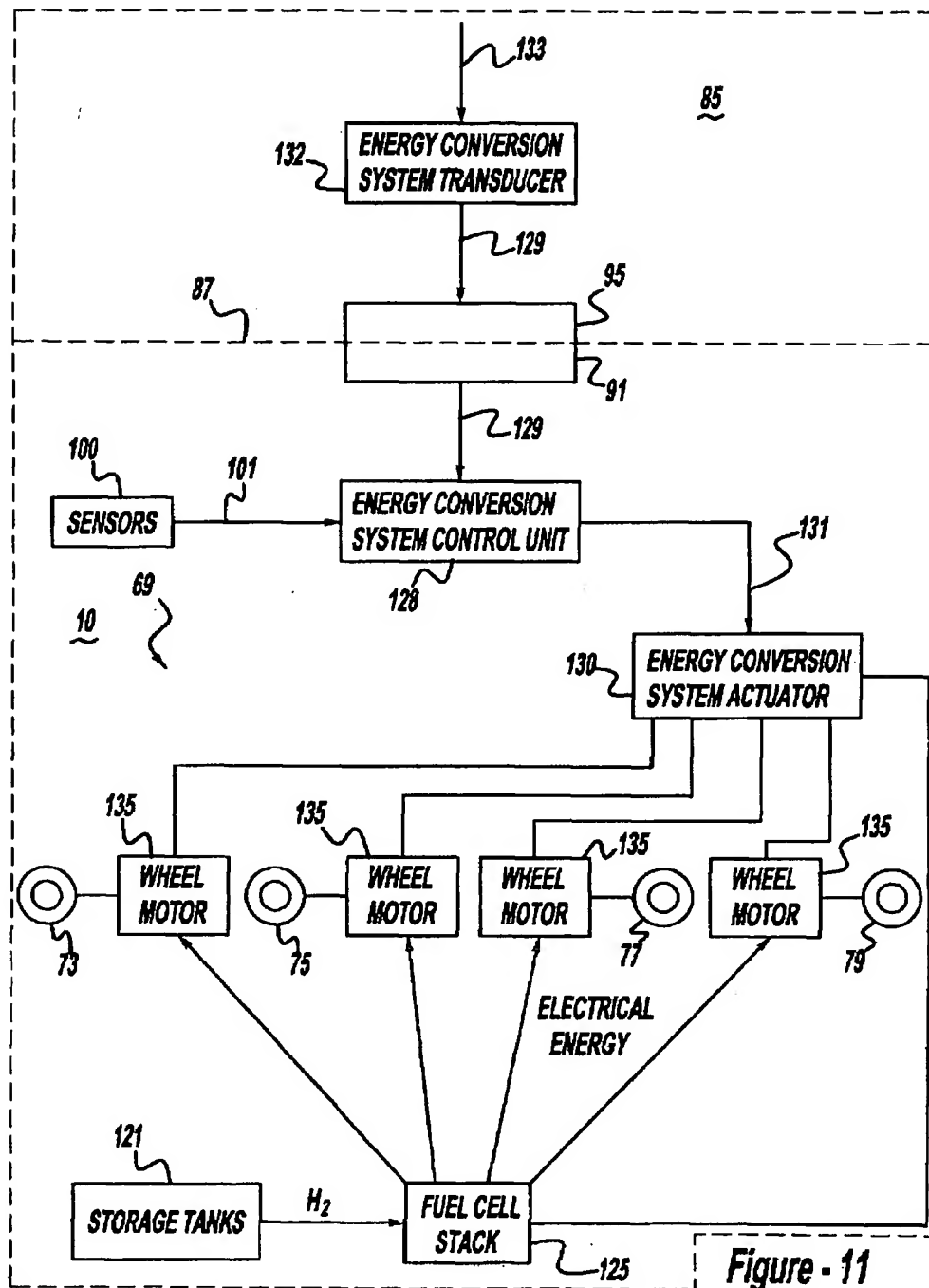


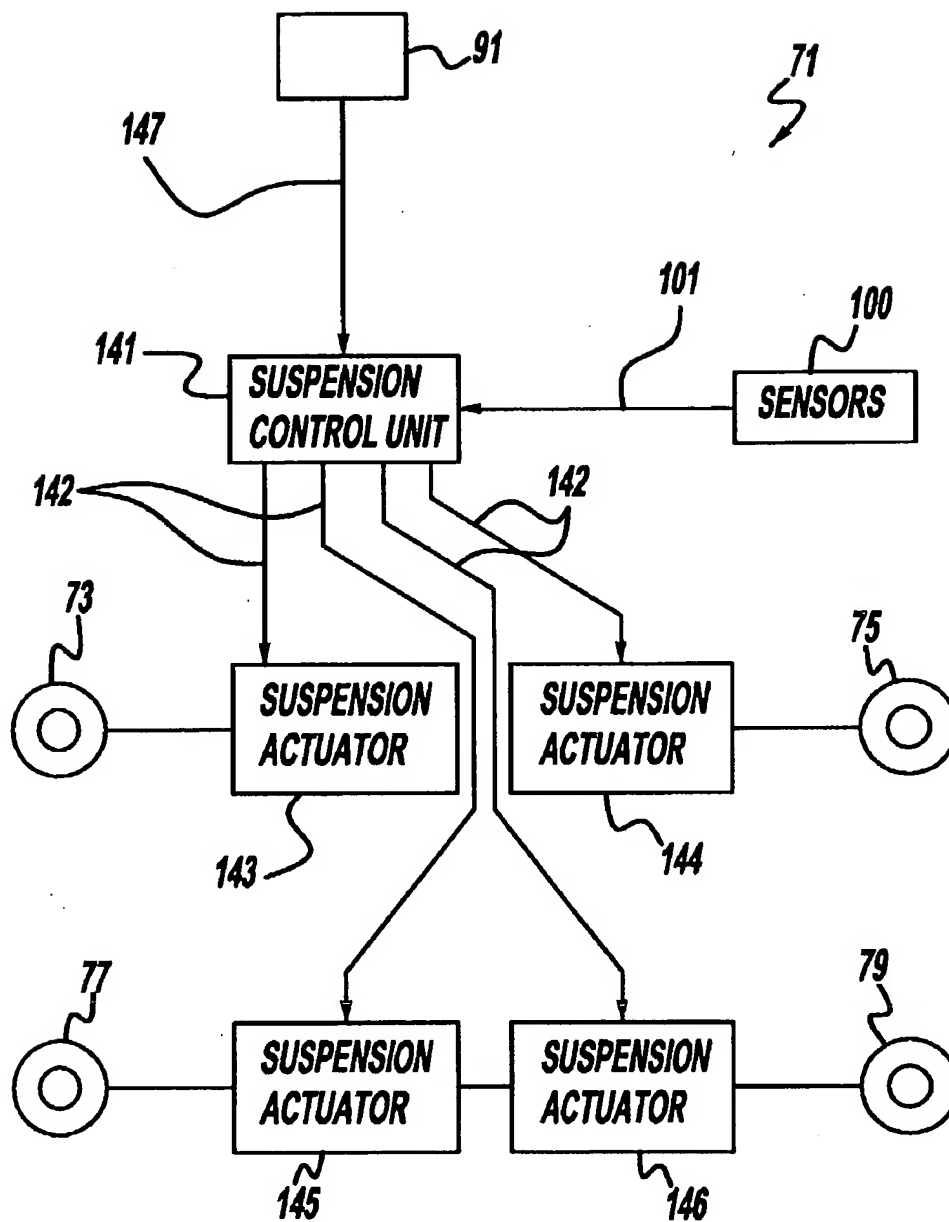
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Figure - 10

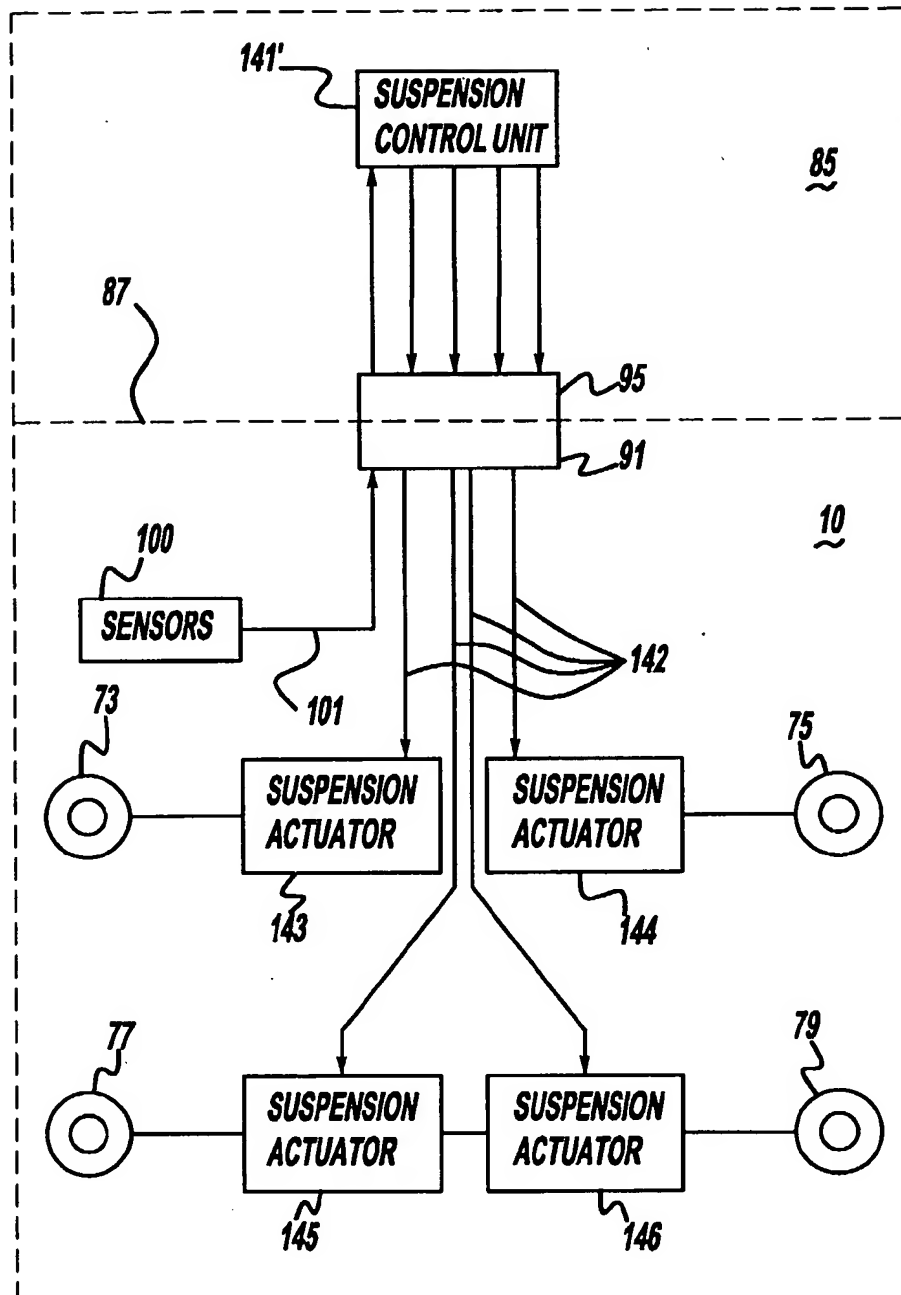


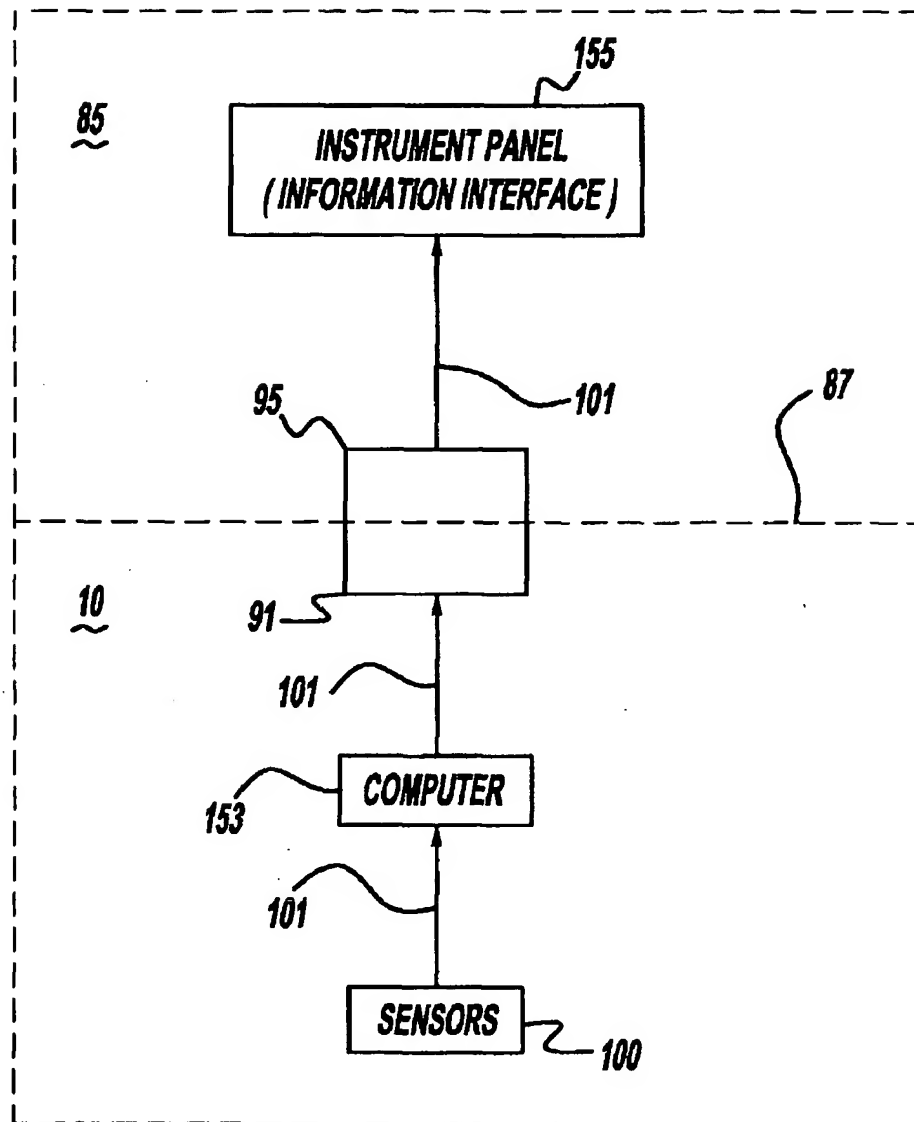






**Figure - 12**

**Figure - 13**

**Figure - 14**

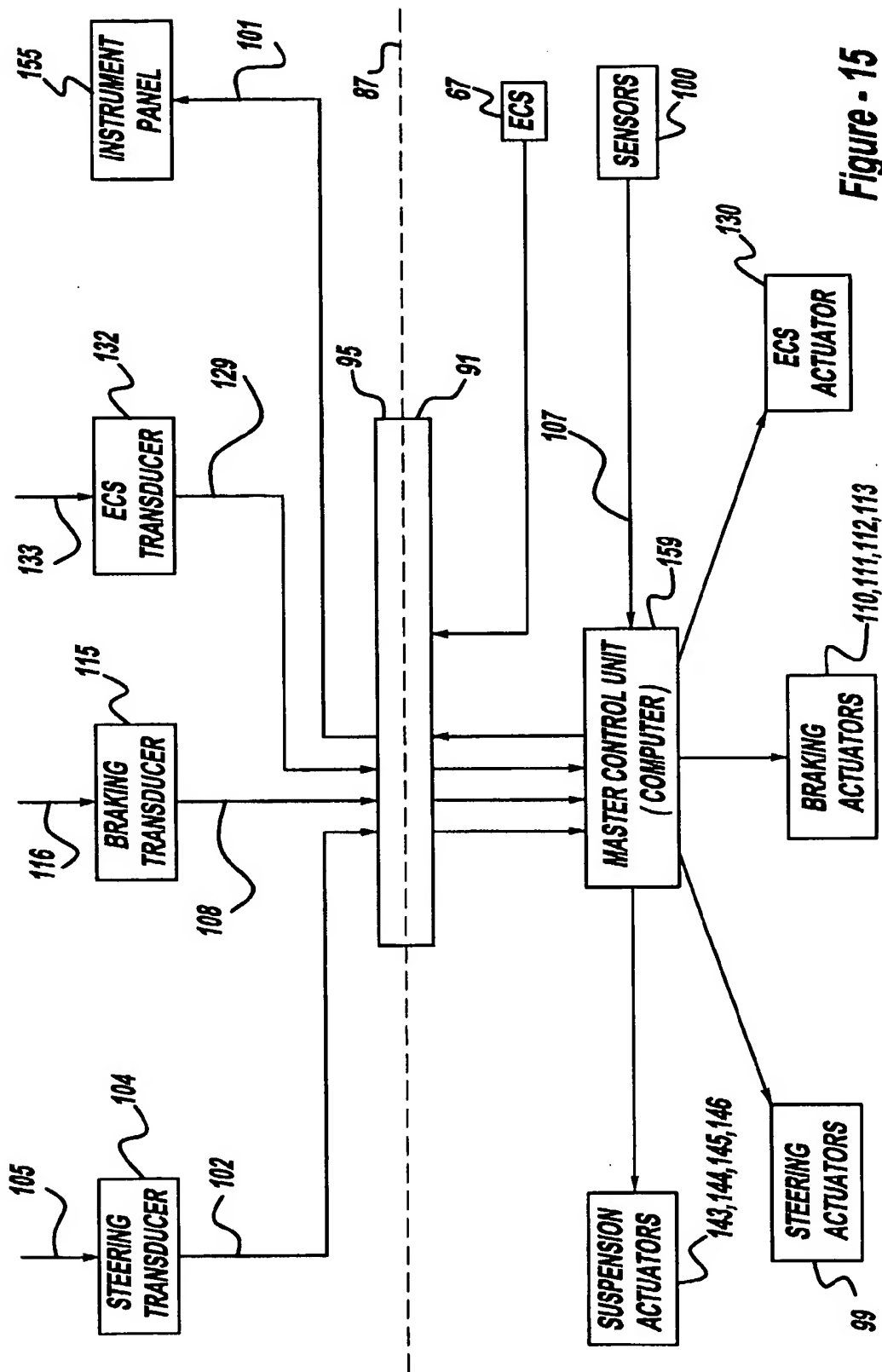


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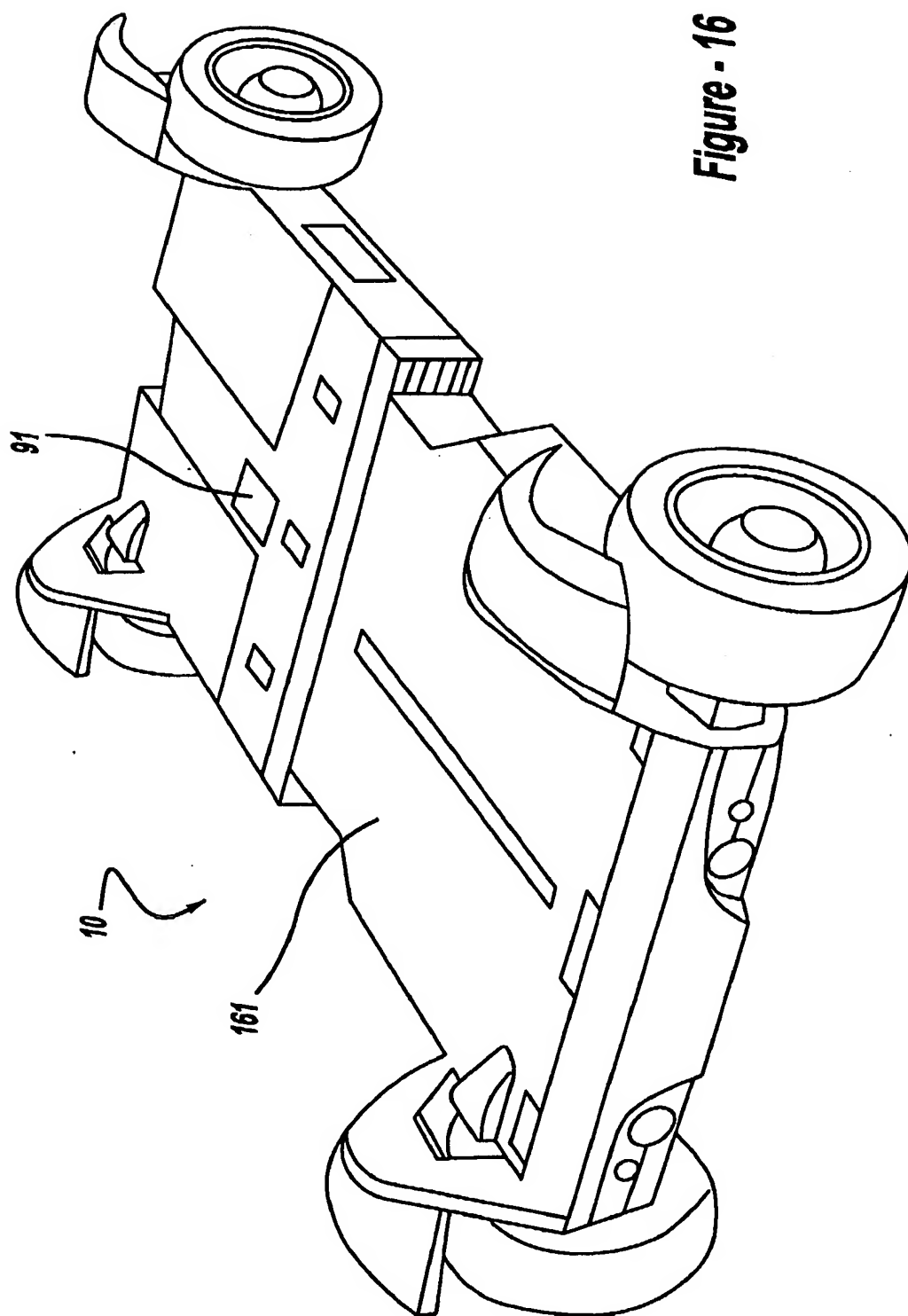


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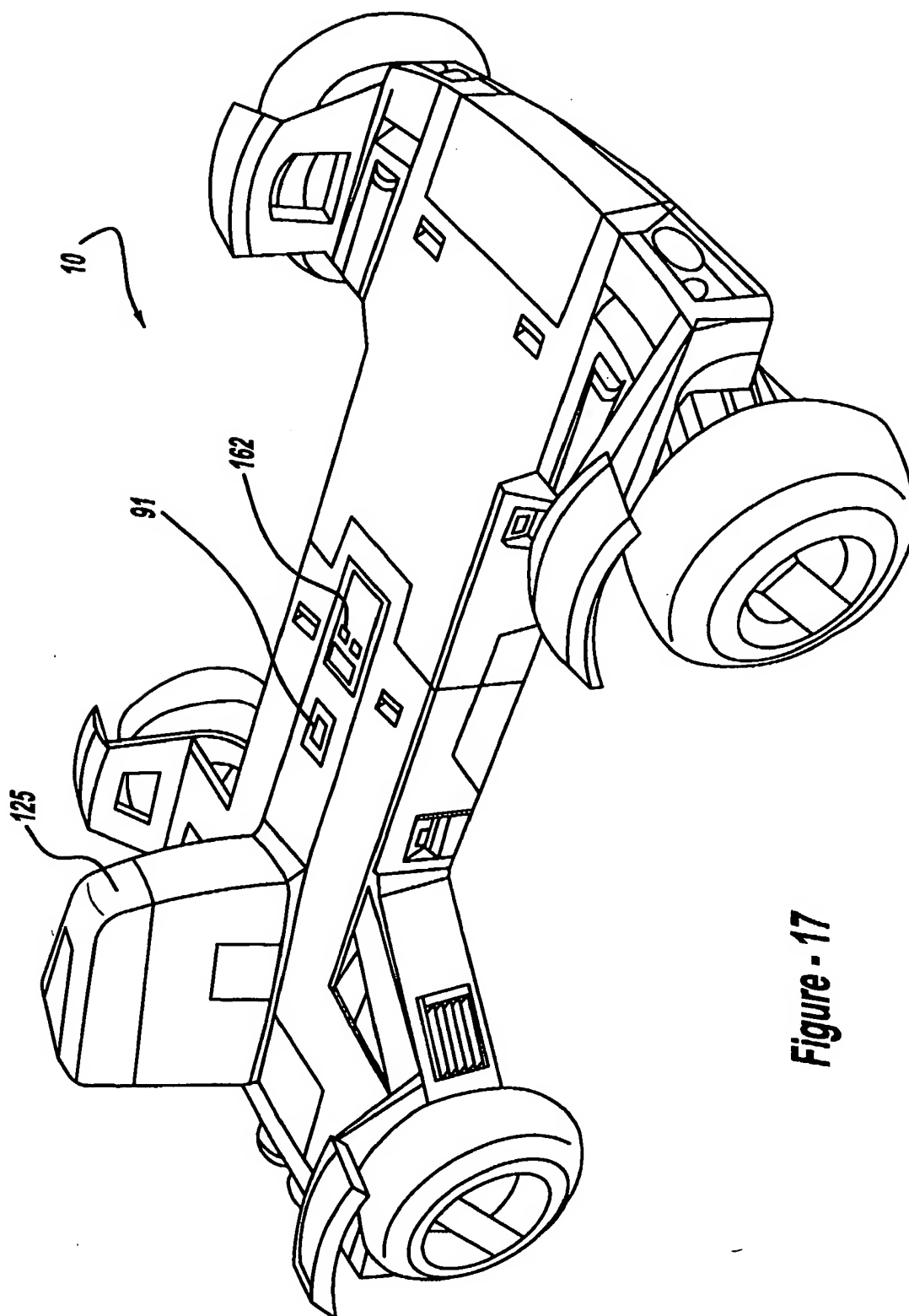


Figure - 17

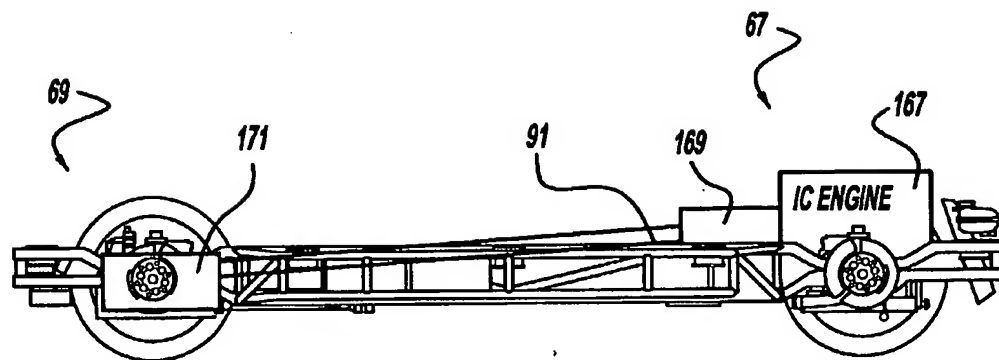


Figure - 18

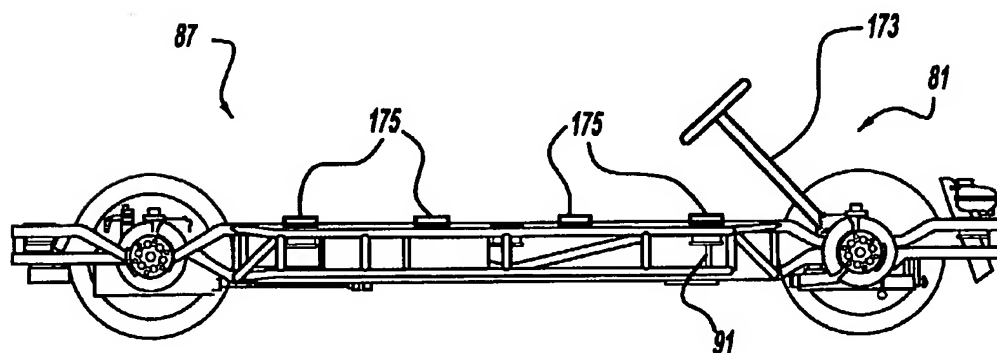
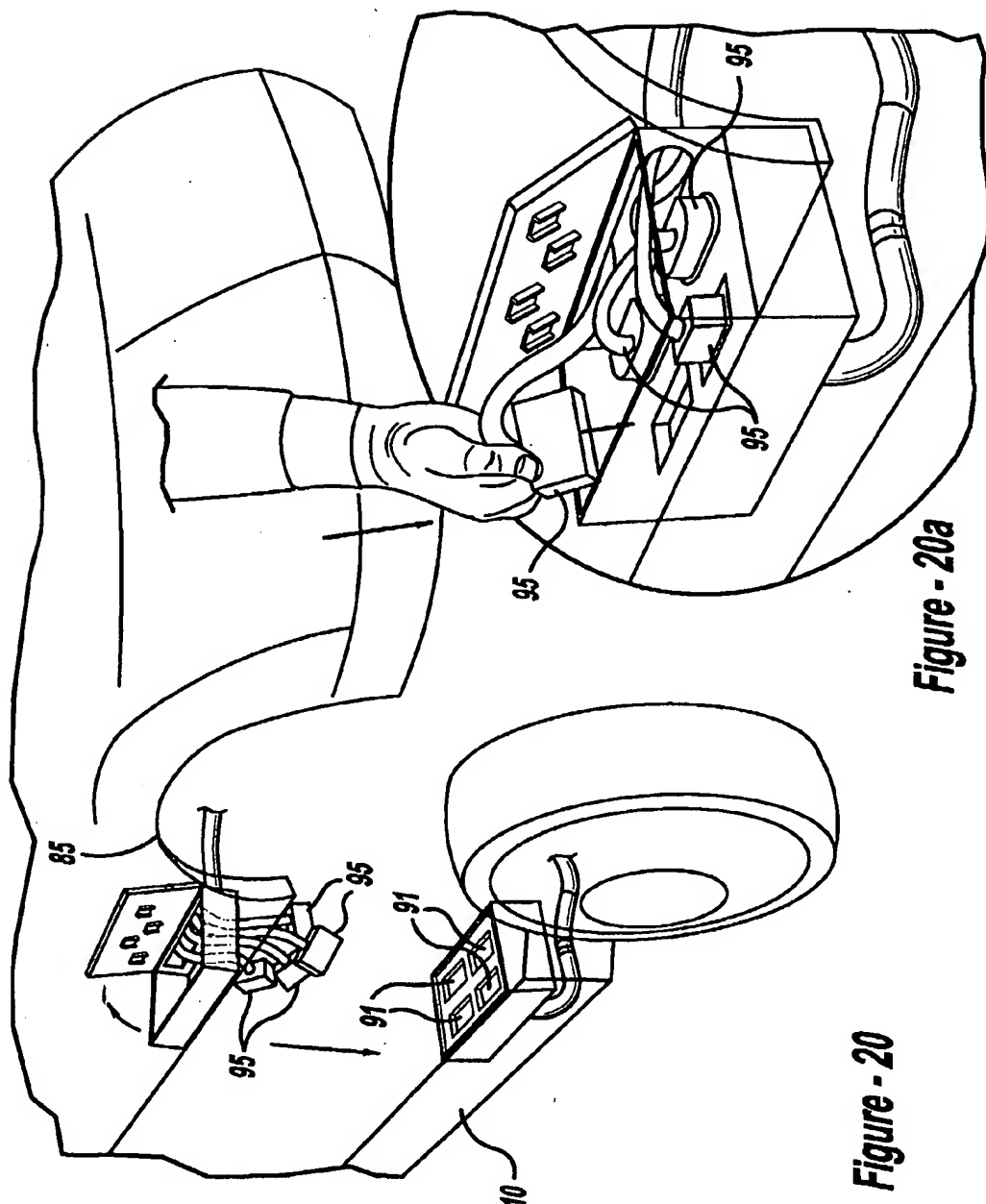


Figure - 19





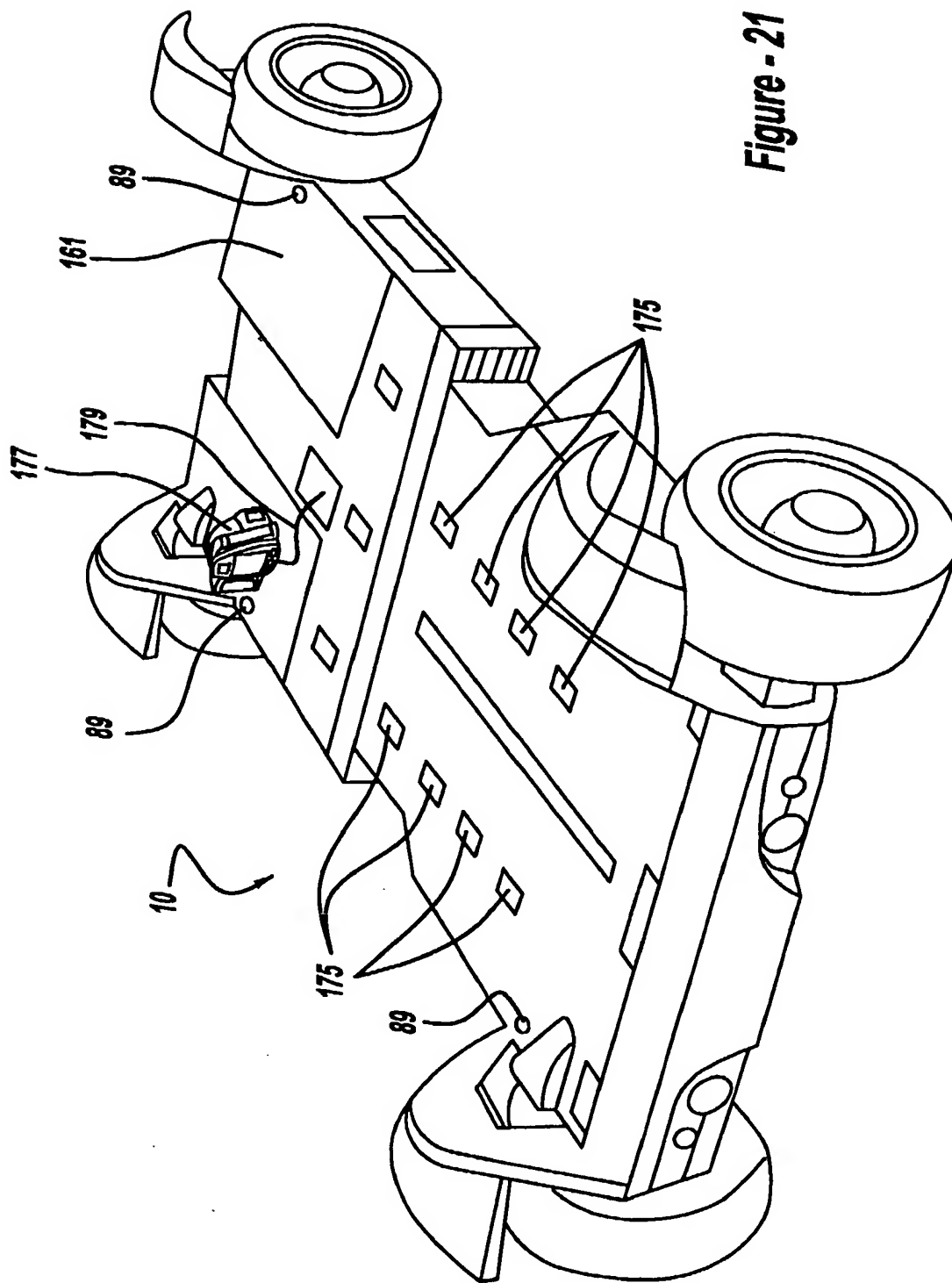


Figure - 21

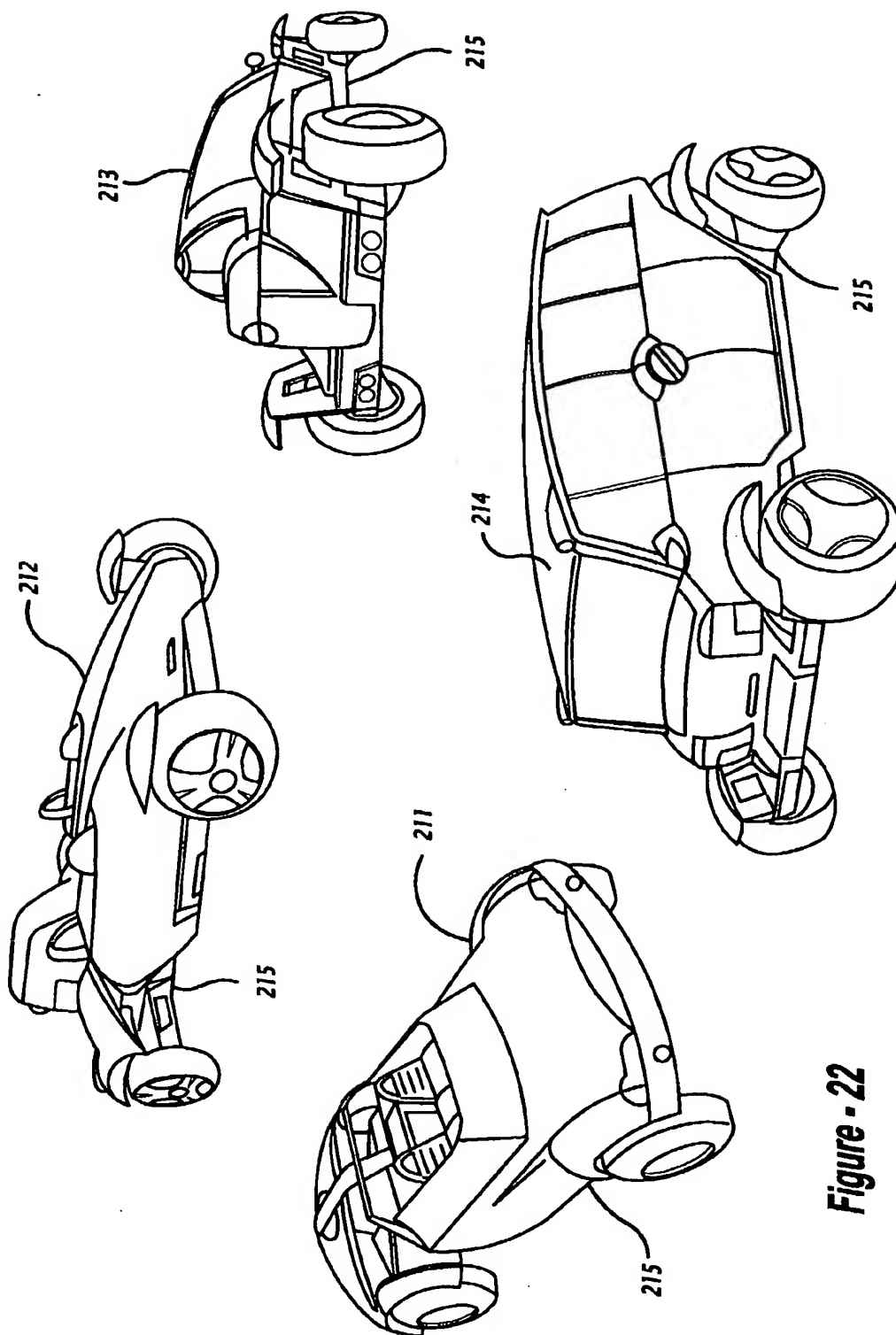


Figure - 22

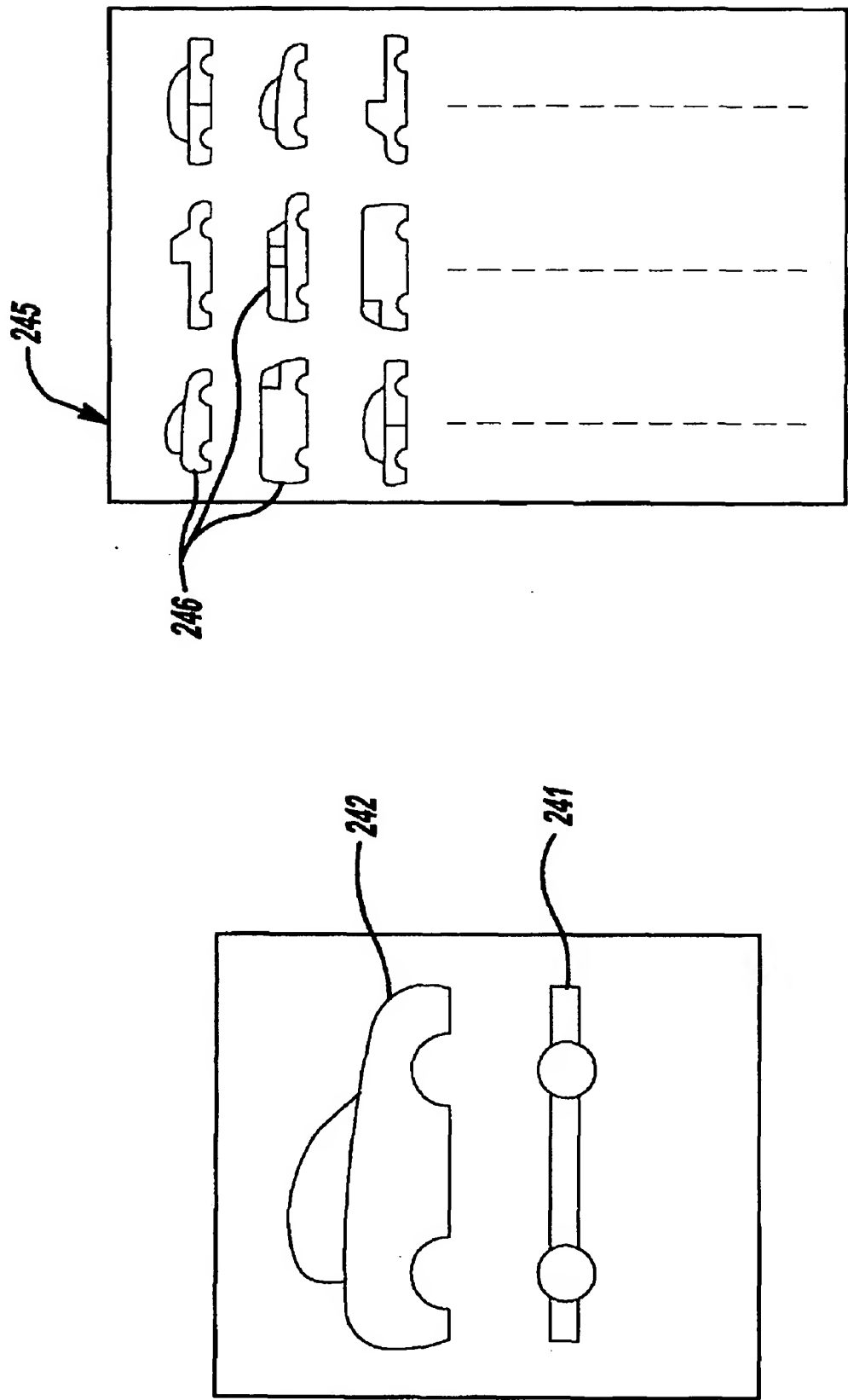


Figure - 23

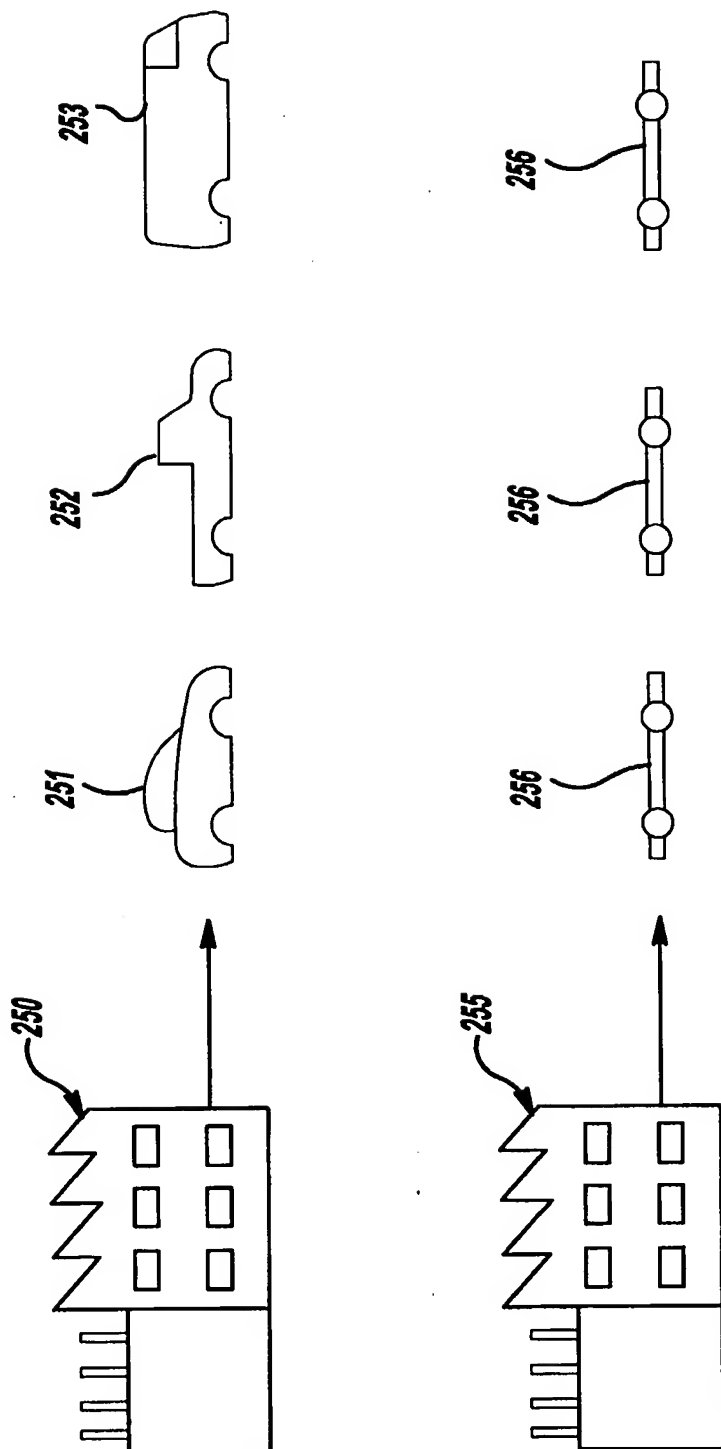


Figure - 24

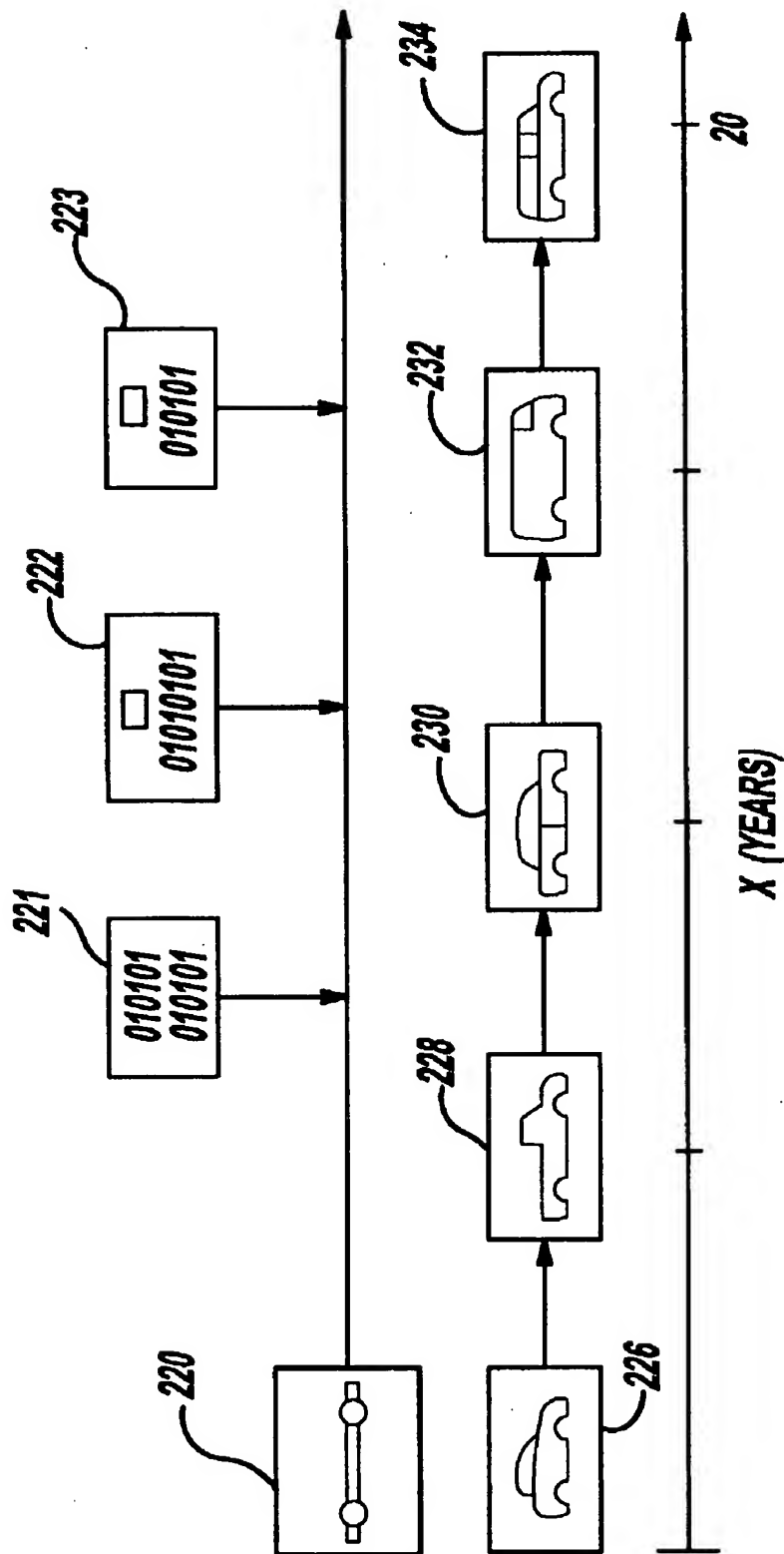


Figure - 25

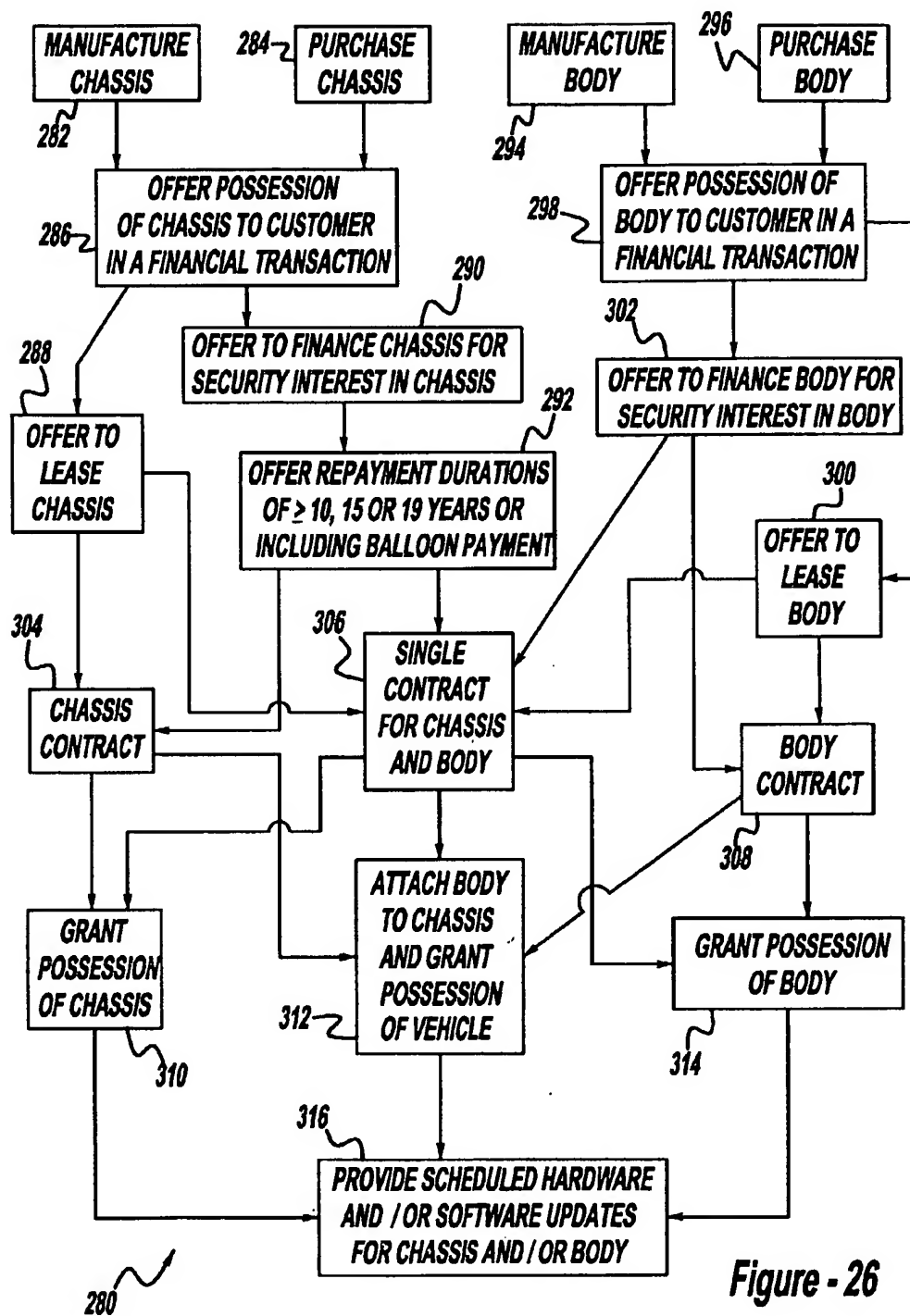


Figure - 26

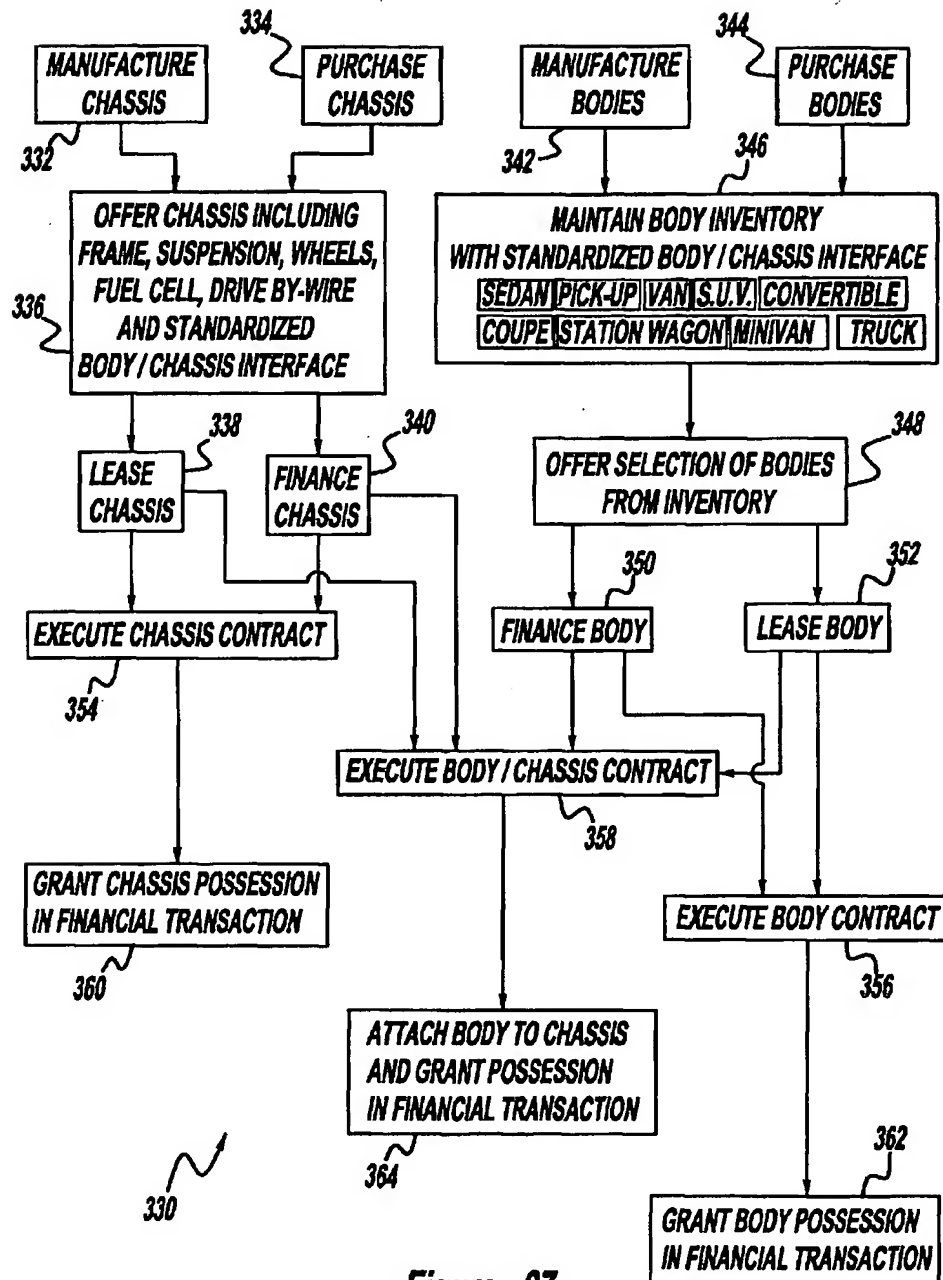


Figure - 27

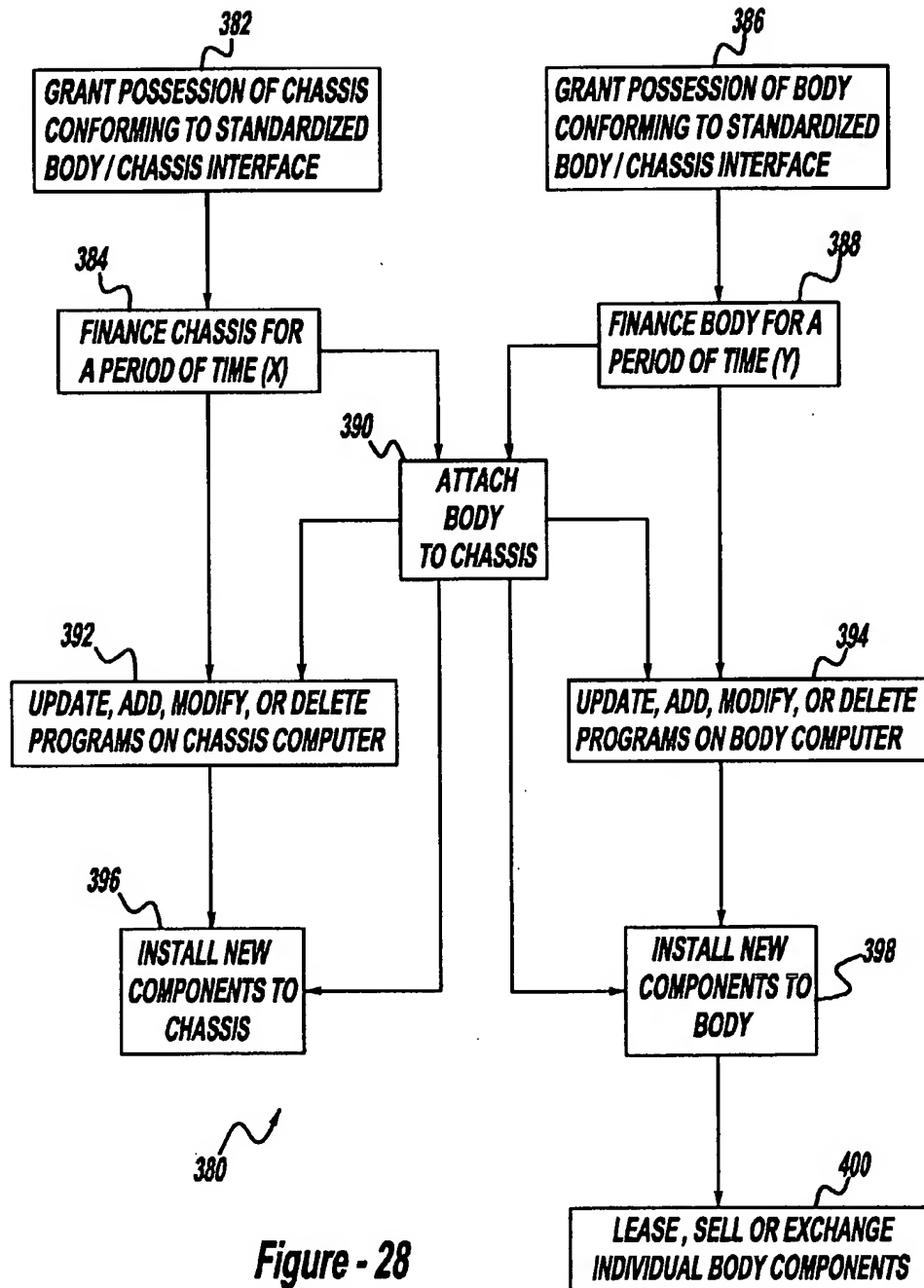


Figure - 28



## METHODS OF CONDUCTING VEHICLE BUSINESS TRANSACTIONS

### CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Applications 60/314,501 and 60/337,994, filed Aug. 23, 2001 and Dec. 7, 2001, both of which are hereby incorporated by reference in their entireties.

### TECHNICAL FIELD

The invention relates to methods of conducting vehicle business transactions with customers, wherein possession of bodies and chassis may be granted under separate financial transactions.

### BACKGROUND OF THE INVENTION

Mobility, being capable of moving from place to place or of moving quickly from one state to another, has been one of the ultimate goals of humanity throughout recorded history. The automobile has likely done more in helping individuals achieve that goal than any other development. Since its inception, societies around the globe have experienced rates of change in their manner of living that are directly related to the percentage of motor vehicle owners among the population.

Prior art automobiles and light trucks include a body, the function of which is to contain and protect passengers and their belongings. Bodies are connected to the numerous mechanical, electrical, and structural components that, in combination with a body, comprise a fully functional vehicle. The nature of the prior art connections between a vehicle body and vehicular componentry may result in certain inefficiencies in the design, manufacture, and use of vehicles. Three characteristics of prior art body connections that significantly contribute to these inefficiencies are the quantity of connections; the mechanical nature of many of the connections; and the locations of the connections on the body and on the componentry.

In the prior art, the connections between a body and componentry are numerous. Each connection involves at least one assembly step when a vehicle is assembled; it is therefore desirable to reduce the number of connections to increase assembly efficiency. The connections between a prior art body and prior art vehicular componentry include multiple load-bearing connectors to physically fasten the body to the other components, such as bolts and brackets; electrical connectors to transmit electrical energy to the body from electricity-generating components and to transmit data from sensors that monitor the status of the componentry; mechanical control linkages, such as the steering column, throttle cable, and transmission selector; and ductwork and hoses to convey fluids such as heated and cooled air from an HVAC unit to the body for the comfort of passengers.

Many of the connections in the prior art, particularly those connections that transmit control signals, are mechanical linkages. For example, to control the direction of the vehicle, a driver sends control signals to the steering system via a steering column. Mechanical linkages result in inefficiencies, in part, because different driver locations in different vehicles require different mechanical linkage dimensions and packaging. Thus, new or different bodies often cannot use "off-the-shelf" components and linkages. Componentry

for one vehicle body configuration is typically not compatible for use with other vehicle body configurations. Furthermore, if a manufacturer changes the design of a body, a change in the design of the mechanical linkage and the component to which it is attached may be required. The change in design of the linkages and components requires modifications to the tooling that produces the linkages and components.

The location of the connections on prior art vehicle bodies and componentry also results in inefficiencies. In prior art body-on-frame architecture, connection locations on the body are often not exposed to an exterior face of the body, and are distant from corresponding connections on the componentry; therefore, long connectors such as wiring harnesses and cables must be routed throughout the body from componentry. The vehicle body of a fully-assembled prior art vehicle is intertwined with the componentry, and the connection devices, rendering separation of the body from its componentry difficult and labor-intensive, if not impossible. The use of long connectors increases the number of assembly steps required to attach a vehicle to its componentry.

Furthermore, prior art vehicles typically have internal combustion engines that have a height that is a significant proportion of the overall vehicle height. Prior art vehicle bodies are therefore designed with an engine compartment that occupies about a third of the front (or sometimes the rear) of the body length. Compatibility between an engine and a vehicle body requires that the engine fit within the body's engine compartment without physical part interference. Moreover, compatibility between a prior art chassis with an internal combustion engine and a vehicle body requires that the body have an engine compartment located such that physical part interference is avoided. For example, a vehicle body with an engine compartment in the rear is not compatible with a chassis with an engine in the front.

Additionally, prior art vehicles are traditionally leased, sold, rented or financed as a single unit including a chassis and body. Leasing and financing terms typically extend one to five year periods of time.

### SUMMARY OF THE INVENTION

A self-contained chassis has substantially all of the mechanical, electrical, and structural componentry necessary for a fully functional vehicle, including at least an energy conversion system, a suspension and wheels, a steering system, and a braking system. The chassis has a simplified, and preferably standardized, interface with connection components to which bodies of substantially varying design can be attached. X-by-wire technology is utilized to eliminate mechanical control linkages.

As a result, the amount of time and resources required to design and manufacture new vehicle bodies are reduced. Body designs need only conform to the simple attachment interface of the chassis, eliminating the need to redesign or reconfigure expensive components.

Further, a multitude of body configurations share a common chassis, enabling economies of scale for major mechanical, electrical, and structural components.

Connection components, exposed and unobstructed, increase manufacturing efficiency because attachment of a body to the chassis requires only engagement of the connection components to respective complementary connection components on a vehicle body.

Vehicle owners can increase the functionality of their vehicles at a lower cost than possible with the prior art

because a vehicle owner need buy only one chassis upon which to mount a multitude of body styles.

A feature of the invention is that a vehicle chassis/powertrain frame (a.k.a. rolling platform) is obtained by the customer for an unconventionally long number of years. As opposed to the typical 1-5 year finance or leasing term of the prior art, the rolling chassis may be leased or financed and used for 20 years or more.

A method of conducting a vehicle business transaction with a customer includes the steps of: A) offering to grant possession of a vehicle chassis to the customer in a first financial transaction for consideration; and B) offering to grant possession of a vehicle body engageable with the chassis to the customer in a second financial transaction for consideration independently of the vehicle chassis, wherein the chassis and the body are separately priced.

The customer may or may not be an end user of the vehicle. The chassis and body may be financed independently of each other, and separate security interests may be acquired in the chassis and body. The chassis and body may also have separate repayment plans with separate durations. The repayment duration for the chassis may exceed 10, 15, or 19 years.

The financing terms may include scheduled hardware or software upgrades.

Possession of the chassis and/or body may be granted separately, or the body may be attached to the chassis prior to granting possession.

The first and second financial transactions for the vehicle chassis and vehicle body may be defined by a single contract establishing different terms for the chassis and body, or by separate contracts.

Further, a body inventory may be maintained, and the body may be selected from the inventory for attachment to a chassis.

The above objects, features, advantages, and other objects, features and advantages of the present invention are readily apparent from the following detailed description of the best modes for carrying out the invention when taken in connection with the accompanying drawings.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic illustration in perspective view of a vehicle rolling platform according to an embodiment of the present invention;

FIG. 2 is a top view schematic illustration of the vehicle rolling platform shown in FIG. 1;

FIG. 3 is a bottom view schematic illustration of the vehicle rolling platform shown in FIGS. 1 and 2;

FIG. 4 is a schematic illustration in side view of a vehicle body pod and rolling platform attachment scenario according to the present invention that is useful with the embodiment of FIGS. 1-3;

FIG. 5 is a schematic illustration of a vehicle body pod and rolling platform attachment scenario, wherein body pods of differing configurations are each attachable to identical rolling platforms;

FIG. 6 is a schematic illustration of a steering system for use with the rolling platform and body pod shown in FIG. 4;

FIG. 7 is a schematic illustration of an alternative steering system for use in the rolling platform and body pod of FIG. 4;

FIG. 8 is a schematic illustration of a braking system for use with the rolling platform and body pod of FIG. 4;

FIG. 9 is a schematic illustration of an alternative braking system for use with the rolling platform and body pod of FIG. 4;

FIG. 10 is a schematic illustration of an energy conversion system for use with the rolling platform and body pod of FIG. 4;

FIG. 11 is a schematic illustration of an alternative energy conversion system for use with the rolling platform and body pod of FIG. 4;

FIG. 12 is a schematic illustration of a suspension system for use with the rolling platform of FIGS. 1-5;

FIG. 13 is a schematic illustration of an alternative suspension system for use with the rolling platform and body pod of FIG. 4;

FIG. 14 is a schematic illustration of a chassis computer and chassis sensors for use with the rolling platform and body pod of FIG. 4;

FIG. 15 is a schematic illustration of a master control unit with a suspension system, braking system, steering system, and energy conversion system for use with the rolling platform and body pod of FIG. 4;

FIG. 16 is a perspective illustration of a skinned rolling platform according to a further embodiment of the present invention;

FIG. 17 is a perspective illustration of a skinned rolling platform according to another embodiment of the present invention;

FIG. 18 is a side schematic illustration of a rolling platform with an energy conversion system including an internal combustion engine, and gasoline tanks;

FIG. 19 is a side schematic illustration of a rolling platform according to another embodiment of the invention, with a mechanical steering linkage and passenger seating attachment couplings;

FIGS. 20 and 20a show partial exploded perspective schematic illustrations of a rolling platform according to a further embodiment of the invention in an attachment scenario with a body pod, the rolling platform having multiple electrical connectors engageable with complementary electrical connectors in the body pod;

FIG. 21 is a perspective schematic illustration of a skinned rolling platform according to yet another embodiment of the invention, the rolling platform having a movable control input device;

FIG. 22 is an illustration of a body selection grouping showing perspective views of vehicles according to various aspects of the present invention;

FIG. 23 is a process diagram illustrating a body inventory and a chassis with a removable body in accordance with the invention;

FIG. 24 is a process diagram illustrating body and chassis manufacturing operations;

FIG. 25 is a flow chart illustrating interchangeability of vehicle bodies with a single chassis over an extended period of time, and including software and hardware upgrades;

FIG. 26 is a flow chart of a method of conducting vehicle business transactions with customers;

FIG. 27 is a flowchart of an alternative method of conducting vehicle business transactions with customers; and

FIG. 28 is a flow chart representing a further method of conducting vehicle business transactions with customers.

### DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a vehicle chassis 10 in accordance with the invention, also referred to as the "rolling platform,"

includes a structural frame 11. The structural frame 11 depicted in FIG. 1 comprises a series of interconnected structural elements including upper and lower side structural elements 12 and 14 that comprise a "sandwich"-like construction. Elements 12 and 14 are substantially rigid tubular (or optionally solid), members that extend longitudinally between the front and rear axle areas 16, 18, and are positioned outboard relative to similar elements 20, 22. The front and rear ends of elements 12, 14 are angled inboard, extending toward elements 20 and 22 and connecting therewith prior to entering the axle areas 16, 18. For added strength and rigidity a number of vertical and angled structural elements extend between elements 12, 14, 20 and 22. Similar to the elements 12, 14, 20 and 22, which extend along the left side of the rolling platform 10, a family of structural elements 26, 28, 30 and 32 extend along the right side thereof.

Lateral structural elements 34, 36 extend between elements 20, 30 and 22, 32, respectively nearer the front axle area 16 and lateral structural elements 38, 40 extend between elements 20, 30 and 22, 32, respectively nearer the rear axle area 18, thereby defining a mid-chassis space 41. The front axle area 16 is defined in and around structural elements 43, 44 at the rear and front, and on the sides by structural elements 46, 48 which may be extensions of the elements 20, 22, 30, 32 or connected therewith. Forward of the front axle area, a forward space is defined between element 44 and elements 50, 52. The rear axle area 18 is defined in and around structural elements 53, 54 at the front and rear, and on the sides by structural elements 56, 58, which may be extensions of the elements 20, 22, 30, 32 or connected therewith. Rearward of the rear axle area 18, a rearward space is defined between element 54 and elements 60, 62. Alternatively, the rear axle area 18 or the rearward space may be elevated relative to the rest of the structural frame 11 if necessary to accommodate an energy conversion system, and the frame may include other elements to surround and protect an energy conversion system. The frame defines a plurality of open spaces between the elements described above. Those skilled in the art will recognize materials and fastening methods suitable for use in the structural frame. For example, the structural elements may be tubular, aluminum, and welded at their respective connections to other structural elements.

The structural frame 11 provides a rigid structure to which an energy conversion system 67, energy storage system 69, suspension system 71 with wheels 73, 75, 77, 79 (each wheel having a tire 80), steering system 81, and braking system 83 are mounted, as shown in FIGS. 1-3, and is configured to support an attached body 85, as shown in FIG. 4. A person of ordinary skill in the art will recognize that the structural frame 11 can take many different forms, in addition to the cage-like structure of the embodiment depicted in FIGS. 1-3. For example, the structural frame 11 can be a traditional automotive frame having two or more longitudinal structural members spaced a distance apart from each other, with two or more transverse structural members spaced apart from each other and attached to both longitudinal structural members at their ends. Alternatively, the structural frame may also be in the form of a "belly pan," wherein integrated rails and cross members are formed in sheets of metal or other suitable material, with other formations to accommodate various system components. The structural frame may also be integrated with various chassis components.

Referring to FIG. 2, a body attachment interface 87 is defined as the sum of all body connection components, i.e.,

connective elements that function to operably mate a vehicle body to the chassis 10. The body connection components of the preferred embodiment include a plurality of load-bearing body-retention couplings 89 mounted with respect to the structural frame 11 and a single electrical connector 91.

As shown in FIG. 4, the load-bearing body-retention couplings 89 are engageable with complementary attachment couplings 93 on a vehicle body 85 and function to physically fasten the vehicle body 85 to the chassis 10. Those skilled in the art will recognize that a multitude of fastening and locking elements may be used and fall within the scope of the claimed invention. The load-bearing body-retention couplings 89 are preferably releasably engageable with complementary couplings, though non-releasably engageable couplings such as weld flanges or riveting surfaces may be employed within the scope of the claimed invention. Ancillary fastening elements may be used as lock downs in conjunction with the load-bearing body-retention couplings. Load-bearing surfaces without locking or fastening features on the chassis 10 may be used with the load-bearing body-retention couplings 89 to support the weight of an attached vehicle body 85. In the preferred embodiment, the load-bearing body-retention couplings 89 include support brackets with bolt holes. Rubber mounts (not shown) located on the support brackets dampen vibrations transmitted between the body and the chassis. Alternatively, hard mounts may be employed for body-retention couplings.

The electrical connector 91 is engageable with a complementary electrical connector 95 on a vehicle body 85. The electrical connector 91 of the preferred embodiment may perform multiple functions, or select combinations thereof. First, the electrical connector 91 may function as an electrical power connector, i.e., it may be configured to transfer electrical energy generated by components on the chassis 10 to a vehicle body 85 or other non-chassis destination. Second, the electrical connector 91 may function as a control signal receiver, i.e., a device configured to transfer control signals from a non-chassis source to controlled systems including the energy conversion system, steering system, and braking system. Third, the electrical connector 91 may function as a feedback signal conduit through which feedback signals are made available to a vehicle driver. Fourth, the electrical connector 91 may function as an external programming interface through which software containing algorithms and data may be transmitted for use by controlled systems. Fifth, the electrical connector may function as an information conduit through which sensor information and other information is made available to a vehicle driver. The electrical connector 91 may thus function as a communications and power "umbilical" port through which all communications between the chassis 10 and an attached vehicle body 85 are transmitted. Electrical connectors include devices configured to operably connect one or more electrical wires with other electrical wires. The wires may be spaced a distance apart to avoid any one wire causing signal interference in another wire operably connected to an electrical connector or for any reason that wires in close proximity may not be desirable.

If one electrical connector performing multiple functions is not desirable, for example, if a cumbersome wire bundle is required, or power transmission results in control signal interference, the body attachment interface 87 may include a plurality of electrical connectors 91 engageable with a plurality of complementary electrical connectors 95 on a vehicle body 85, with different connectors performing different functions. A complementary electrical connector 95 performs functions complementary to the function of the

electrical connector with which it engages, for example, functioning as a control signal transmitter when engaged with a control signal receiver.

Referring again to FIGS. 1-3, the energy conversion system 67, energy storage system 69, steering system 81, and braking system 83, are configured and positioned on the chassis 10 to minimize the overall vertical height of the chassis 10 and to maintain a substantially horizontal upper chassis face 96. A face of an object is an imaginary surface that follows the contours of the object that face, and are directly exposed to, a particular direction. Thus, the upper chassis face 96 is an imaginary surface that follows the upwardly facing and exposed contours of the chassis frame 11 and systems mounted therein. Matable vehicle bodies have a corresponding lower body face 97 that is an imaginary surface that follows the downwardly facing and exposed contours of the body 85, as shown in FIG. 4.

Referring again to FIGS. 1-3, the structural frame 11 has a height defined as the vertical distance between its highest point (the top of structural element 20) and its lowest point (the bottom of structural element 22). In the preferred embodiment, the structural frame height is approximately 11 inches. To achieve a substantially horizontal upper chassis face 96, the energy conversion system 67, energy storage system 69, steering system 81, and braking system 83 are distributed throughout the open spaces and are configured, positioned, and mounted to the structural frame 11 such that no part of the energy conversion system 67, energy storage system 69, steering system 81, or braking system 83, extends or protrudes above the structural frame 11 more than 50% of the structural frame's 11 height, or above the top of any of the tires 80. The substantially horizontal upper chassis face 96 enables the attached vehicle body 85 to have a passenger area that extends the length of the chassis, unlike prior art bodies that have an engine compartment to accommodate a vertically-protruding internal combustion engine.

Most of the powertrain load is evenly distributed between the front and rear of the chassis so there is a lower center of gravity for the whole vehicle without sacrificing ground clearance, thereby enabling improved handling while resisting rollover forces.

Referring again to FIG. 4, the preferred embodiment of the rolling platform 10 is configured such that the lower body face 97 of a matable vehicle body 85 is positioned closely adjacent to the upper chassis face 96 for engagement with the rolling platform 10. The body connection components have a predetermined spatial relationship relative to one another, and are sufficiently positioned, exposed, and unobstructed such that when a vehicle body 85 having complementary connection components (complementary attachment couplings 93 and a complementary electrical connector 95) in the same predetermined spatial relationship as the body connection components is sufficiently positioned relative to the upper chassis face 96 of a chassis 10 of the invention, the complementary connection components are adjacent to corresponding body connection components and ready for engagement, as depicted in FIG. 4. In the context of the present invention, a body connection component having a protective covering is exposed and unobstructed if the protective covering is removable or retractable.

Each body connection component has a spatial relationship relative to each of the other body connection components that can be expressed, for example, as a vector quantity. Body connection components and complementary connection components have the same predetermined spatial relationship if the vector quantities that describe the spatial relationship between a body connection component and the

other body connection components to be engaged also describe the spatial relationship between a corresponding complementary connection component and the other complementary connection components to be engaged. For example, the spatial relationship may be defined as follows: a first body connection component is spaced a distance  $Ax+By$  from a reference point; a second body connection component is spaced a distance  $Cx+Dy$  from the reference point; a third body connection component is spaced a distance  $Ex+Fy$  from the reference point, etc. Corresponding complementary connection components in the same predetermined spatial relationship are spaced in a mirror image relationship in the lower body face, as depicted in FIGS. 4 and 5. A protective covering (not shown) may be employed to protect any of the body connection components.

The body connection components and the complementary connection components are preferably adjacent without positional modification when a vehicle body 85 is sufficiently positioned relative to a chassis 10 of the invention; however, in the context of the present invention, the body connection components may be movable relative to each other within a predetermined spatial relationship to accommodate build tolerances or other assembly issues. For example, an electrical connector may be positioned and operably connected to a signal-carrying cable. The cable may be fixed relative to the structural frame at a point six inches from the electrical connector. The electrical connector will thus be movable within six inches of the fixed point on the cable. A body connection component is considered adjacent to a complementary connection component if one or both are movable within a predetermined spatial relationship so as to be in contact with each other.

Referring to FIG. 5, the body-attachment interface of the claimed invention enables compatibility between the chassis 10 and different types of bodies 85, 85', 85" having substantially different designs. Bodies 85, 85', 85" having a common base 98 with complementary attachment couplings 93 and complementary electrical connectors 95 in the same predetermined spatial relationship with one another as the predetermined spatial relationship between body connection components on the body-attachment interface 87, are each matable with the chassis 10 by positioning the body 85, 85', 85" relative to the chassis 10 such that each complementary attachment coupling 93 is adjacent to a load-bearing body-retention coupling 89, and the complementary electrical connector 95 is adjacent to the electrical connector 91. In accordance with the preferred embodiment of the present invention, all bodies and chassis comply with this common, standardized interface system, thereby enabling a wide array of different body types and styles to be attached to a single chassis design. The substantially horizontal upper chassis face 96 also facilitates compatibility between the rolling platform 10 and a multitude of differently-configured body styles. The common base 98 functions as a body structural unit and forms the lower body face 97 in the preferred embodiment. FIG. 5 schematically depicts a sedan 85, a van 85', and a pickup truck 85" each having a common base 98.

The body connection components are preferably sufficiently exposed at a chassis face to facilitate attachment to complementary connection components on a matable vehicle body. Similarly, complementary connection components on a matable vehicle body are sufficiently exposed at a body face to facilitate attachment to body connection components on a vehicle chassis. In the preferred embodiment of the invention, the body connection components are

located at or above the upper chassis face for engagement with complementary connection components located at or below a lower body face.

It is within the scope of the claimed invention to employ a connection device to engage or operably connect a body connection component with a distant complementary connection component, in the situation where a vehicle body does not have complementary connection components in the same predetermined spatial relationship as the body connection components on a vehicle chassis. For example, a cable having two connectors, one connector engageable with the electrical connector on a body attachment interface and the other connector engageable with a complementary connector on a matable vehicle body, may be used to operably connect the electrical connector and the complementary connector.

The bodies 85, 85', 85" shown schematically in FIG. 5 each use all of the body connection components on the vehicle chassis 10. However, within the scope of the claimed invention, a chassis may have more body connection components than are actually mated with a vehicle body. For example, a chassis may have ten load-bearing body-retention couplings, and be matable with a body that engages only five of the ten load-bearing body-retention couplings. Such an arrangement is particularly useful when an attachable body is of a different size than the chassis. For example, a matable body may be smaller than a chassis. Similarly, and within the scope of the claimed invention, a body may be modular such that separate body components are independently connected to the vehicle chassis by the load-bearing body-retention couplings.

A body may have more complementary connection components than are engageable with the body connection components of a particular chassis. Such an arrangement may be employed to enable a particular body to be matable to multiple chassis each having a different predetermined spatial relationship among its body connection components.

The load-bearing body-retention couplings 89 and the electrical connector 91 are preferably releasably engageable without damage to either an attached body 85 or the chassis 10, thereby enabling removal of one body 85 from the chassis 10 and installation of a different body 85', 85" on the chassis 10.

In the preferred embodiment, the body-attachment interface 87 is characterized by the absence of any mechanical control signal-transmission linkages and any couplings for attaching mechanical control signal-transmission linkages. Mechanical control linkages, such as steering columns, limit the compatibility between a chassis and bodies of different configurations.

Referring to FIG. 1, the steering system 81 is housed in the front axle area 16 and is operably connected to the front wheels 73, 75. Preferably, the steering system 81 is responsive to non-mechanical control signals. In the preferred embodiment, the steering system 81 is by-wire. A by-wire system is characterized by control signal transmission in electrical form. In the context of the present invention, "by-wire" systems, or systems that are controllable "by-wire," include systems configured to receive control signals in electronic form via a control signal receiver on the body attachment interface 87, and respond in conformity to the electronic control signals.

Referring to FIG. 6, the by-wire steering system 81 of the preferred embodiment includes a steering control unit 98, and a steering actuator 99. Sensors 100 are located on the chassis 10 and transmit sensor signals 101 carrying information concerning the state or condition of the chassis 10

and its component systems. The sensors 100 may include position sensors, velocity sensors, acceleration sensors, pressure sensors, force and torque sensors, flow meters, temperature sensors, etc. The steering control unit 98 receives and processes sensor signals 101 from the sensors 100 and electrical steering control signals 102 from the electrical connector 91, and generates steering actuator control signals 103 according to a stored algorithm. A control unit typically includes a microprocessor, ROM and RAM and appropriate input and output circuits of a known type for receiving the various input signals and for outputting the various control commands to the actuators. Sensor signals 101 may include yaw rate, lateral acceleration, angular wheel velocity, tie-rod force, steering angle, chassis velocity, etc.

The steering actuator 99 is operably connected to the front wheels 73, 75 and configured to adjust the steering angle of the front wheels 73, 75 in response to the steering actuator control signals 103. Actuators in a by-wire system transform electronic control signals into a mechanical action or otherwise influence a system's behavior in response to the electronic control signals. Examples of actuators that may be used in a by-wire system include electromechanical actuators such as electric servomotors, translational and rotational solenoids, magnetorheological actuators, electrohydraulic actuators, and electrorheological actuators. Those skilled in the art will recognize and understand mechanisms by which the steering angle is adjusted. In the preferred embodiment, the steering actuator 99 is an electric drive motor configured to adjust a mechanical steering rack.

Referring again to FIG. 6, the preferred embodiment of the chassis 10 is configured such that it is steerable by any source of compatible electrical steering control signals 102 connected to the electrical connector 91. FIG. 6 depicts a steering transducer 104 located on an attached vehicle body 85 and connected to a complementary electrical connector 95. Transducers convert the mechanical control signals of a vehicle driver to non-mechanical control signals. When used with a by-wire system, transducers convert the mechanical control signals to electrical control signals usable by the by-wire system. A vehicle driver inputs control signals in mechanical form by turning a wheel, depressing a pedal, pressing a button, or the like. Transducers utilize sensors, typically position and force sensors, to convert the mechanical input to an electrical signal. In the preferred embodiment, a +/-20 degree slide mechanism is used for driver input, and an optical encoder is used to read input rotation.

The complementary electrical connector 95 is coupled with the electrical connector 91 of the body attachment interface 87. The steering transducer 104 converts vehicle driver-initiated mechanical steering control signals 105 to electrical steering control signals 102 which are transmitted via the electrical connector 91 to the steering control unit 98. In the preferred embodiment, the steering control unit 98 generates steering feedback signals 106 for use by a vehicle driver and transmits the steering feedback signals 106 through the electrical connector 91. Some of the sensors 100 monitor linear distance movement of the steering rack and vehicle speed. This information is processed by the steering control unit 98 according to a stored algorithm to generate the steering feedback signals 106. A torque control motor operably connected to the slide mechanism receives the steering feedback signals 106 and is driven in the opposite direction of the driver's mechanical input.

In the context of the present invention, a "by-wire" system may be an actuator connected directly to an electrical connector in the body attachment interface. An alternative



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by-wire steering system 81' within the scope of the claimed invention is depicted schematically in FIG. 7, wherein like reference numbers refer to like components from FIG. 6. A steering actuator 99 configured to adjust the steering angle of the front wheels 73, 75 is connected directly to the electrical connector 91. In this embodiment, a steering control unit 98' and a steering transducer 104 may be located in an attached vehicle body 85. The steering transducer 104 would transmit electrical steering control signals 102 to the steering control unit 98', and the steering control unit 98' would transmit steering actuator control signals 103 to the steering actuator 99 via the electrical connector 91. Sensors 100 positioned on the chassis 10 transmit sensor signals 101 to the steering control unit 98' via the electrical connector 91 and the complementary electrical connector 95.

Examples of steer-by-wire systems are described in U.S. Pat. No. 6,176,341, issued Jan. 23, 2001 to Delphi Technologies, Inc.; U.S. Pat. No. 6,208,923, issued Mar. 27, 2001 to Robert Bosch GmbH; U.S. Pat. No. 6,219,604, issued Apr. 17, 2001 to Robert Bosch GmbH; U.S. Pat. No. 6,318,494, issued Nov. 20, 2001 to Delphi Technologies, Inc.; U.S. Pat. No. 6,370,460, issued Apr. 9, 2002 to Delphi Technologies, Inc.; and U.S. Pat. No. 6,394,218, issued May 28, 2002 to TRW Fahrwerksysteme GmbH & Co. KG; which are hereby incorporated by reference in their entireties.

The steer-by-wire system described in U.S. Pat. No. 6,176,341 includes a position sensor for sensing angular position of a road wheel, a hand-operated steering wheel for controlling direction of the road wheel, a steering wheel sensor for sensing position of the steering wheel, a steering wheel actuator for actuating the hand-operated steering wheel, and a steering control unit for receiving the sensed steering wheel position and the sensed road wheel position and calculating actuator control signals, preferably including a road wheel actuator control signal and a steering wheel actuator control signal, as a function of the difference between the sensed road wheel position and the steering wheel position. The steering control unit commands the road wheel actuator to provide controlled steering of the road wheel in response to the road wheel actuator control signal. The steering control unit further commands the steering wheel actuator to provide feedback force actuation to the hand-operated steering wheel in response to the steering wheel control signal. The road wheel actuator control signal and steering wheel actuator control signal are preferably scaled to compensate for difference in gear ratio between the steering wheel and the road wheel. In addition, the road wheel actuator control signal and steering wheel actuator control signal may each have a gain set so that the road wheel control actuator signal commands greater force actuation to the road wheel than the feedback force applied to the steering wheel.

The steer-by-wire system described in U.S. Pat. No. 6,176,341 preferably implements two position control loops, one for the road wheel and one for the hand wheel. The position feedback from the steering wheel becomes a position command input for the road wheel control loop and the position feedback from the road wheel becomes a position command input for the steering wheel control loop. A road wheel error signal is calculated as the difference between the road wheel command input (steering wheel position feedback) and the road wheel position. Actuation of the road wheel is commanded in response to the road wheel error signal to provide controlled steering of the road wheel. A steering wheel error signal is calculated as the difference between the steering wheel position command (road wheel

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position feedback) and the steering wheel position. The hand-operated steering wheel is actuated in response to the steering wheel error signal to provide force feedback to the hand-operated steering wheel.

The steering control unit of the '341 system could be configured as a single processor or multiple processors and may include a general-purpose microprocessor-based controller, that may include a commercially available off-the-shelf controller. One example of a controller is Model No. 87C196CA microcontroller manufactured and made available from Intel Corporation of Delaware. The steering control unit preferably includes a processor and memory for storing and processing software algorithms, has a clock speed of 16 MHz, two optical encoder interfaces to read position feedbacks from each of the actuator motors, a pulse width modulation output for each motor driver, and a 5-volt regulator.

U.S. Pat. No. 6,370,460 describes a steer-by-wire control system comprising a road wheel unit and a steering wheel unit that operate together to provide steering control for the vehicle operator. A steering control unit may be employed to support performing the desired signal processing. Signals from sensors in the road wheel unit, steering wheel unit, and vehicle speed are used to calculate road wheel actuator control signals to control the direction of the vehicle and steering wheel torque commands to provide tactile feedback to the vehicle operator. An Ackerman correction may be employed to adjust the left and right road wheel angles correcting for errors in the steering geometry to ensure that the wheels will track about a common turn center.

Referring again to FIG. 1, a braking system 83 is mounted to the structural frame 11 and is operably connected to the wheels 73, 75, 77, 79. The braking system is configured to be responsive to non-mechanical control signals. In the preferred embodiment, the braking system 83 is by-wire, as depicted schematically in FIG. 8, wherein like reference numbers refer to like components from FIGS. 6 and 7. Sensors 100 transmit sensor signals 101 carrying information concerning the state or condition of the chassis 10 and its component systems to a braking control unit 107. The braking control unit 107 is connected to the electrical connector 91 and is configured to receive electrical braking control signals 108 via the electrical connector 91. The braking control unit 107 processes the sensor signals 101 and the electrical braking control signals 108 and generates braking actuator control signals 109 according to a stored algorithm. The braking control unit 107 then transmits the braking actuator control signals 109 to braking actuators 110, 111, 112, 113 which act to reduce the angular velocity of the wheels 73, 75, 77, 79. Those skilled in the art will recognize the manner in which the braking actuators 110, 111, 112, 113 act on the wheels 73, 75, 77, 79. Typically, actuators cause contact between friction elements, such as pads and disc rotors. Optionally, an electric motor may function as a braking actuator in a regenerative braking system.

The braking control unit 107 may also generate braking feedback signals 114 for use by a vehicle driver and transmit the braking feedback signals 114 through the electrical connector 91. In the preferred embodiment, the braking actuators 110, 111, 112, 113 apply force through a caliper to a rotor at each wheel. Some of the sensors 100 measure the applied force on each caliper. The braking control unit 107 uses this information to ensure synchronous force application to each rotor.

Referring again to FIG. 8, the preferred embodiment of the chassis 10 is configured such that the braking system is

responsive to any source of compatible electrical braking control signals 108. A braking transducer 115 may be located on an attached vehicle body 85 and connected to a complementary electrical connector 95 coupled with the electrical connector 91. The braking transducer 115 converts vehicle driver-initiated mechanical braking control signals 116 into electrical form and transmits the electrical braking control signals 106 to the braking control unit via the electrical connector 91. In the preferred embodiment, the braking transducer 115 includes two hand-grip type assemblies. The braking transducer 115 includes sensors that measure both the rate of applied pressure and the amount of applied pressure to the hand-grip assemblies, thereby converting mechanical braking control signals 116 to electrical braking control signals 108. The braking control unit 107 processes both the rate and amount of applied pressure to provide both normal and panic stopping.

An alternative brake-by-wire system 83' within the scope of the claimed invention is depicted in FIG. 9, wherein like reference numbers refer to like components from FIGS. 6-8. The braking actuators 110, 111, 112, 113 and sensors 100 are connected directly to the electrical connector 91. In this embodiment, a braking control unit 107' may be located in an attached vehicle body 85. A braking transducer 115 transmits electrical braking control signals 108 to the braking control unit 107', and the braking control unit 107' transmits braking actuator signals 109 to the braking actuators 110, 111, 112, 113 via the electrical connector 91.

Examples of brake-by-wire systems are described in U.S. Pat. No. 5,366,281, issued Nov. 22, 1994 to General Motors Corporation; U.S. Pat. No. 5,823,636, issued Oct. 20, 1998 to General Motors Corporation; U.S. Pat. No. 6,305,758, issued Oct. 23, 2001 to Delphi Technologies, Inc.; and U.S. Pat. No. 6,390,565, issued May 21, 2002 to Delphi Technologies, Inc.; which are hereby incorporated by reference in their entireties.

The system described in U.S. Pat. No. 5,366,281 includes an input device for receiving mechanical braking control signals, a brake actuator and a control unit coupled to the input device and the brake actuator. The control unit receives brake commands, or electrical braking control signals, from the input device and provides actuator commands, or braking actuator control signals, to control current and voltage to the brake actuator. When a brake command is first received from the input device, the control unit outputs, for a first predetermined time period, a brake torque command to the brake actuator commanding maximum current to the actuator. After the first predetermined time period, the control unit outputs, for a second predetermined time period, a brake torque command to the brake actuator commanding voltage to the actuator responsive to the brake command and a first gain factor. After the second predetermined time period, the control unit outputs the brake torque command to the brake actuator commanding current to the actuator responsive to the brake command and a second gain factor, wherein the first gain factor is greater than the second gain factor and wherein brake initialization is responsive to the brake input.

U.S. Pat. No. 6,390,565 describes a brake-by-wire system that provides the capability of both travel and force sensors in a braking transducer connected to a brake apply input member such as a brake pedal and also provides redundancy in sensors by providing the signal from a sensor responsive to travel or position of the brake apply input member to a first control unit and the signal from a sensor responsive to force applied to a brake apply input member to a second control unit. The first and second control units are connected by a bidirectional communication link whereby each con-

troller may communicate its received one of the sensor signals to the other control unit. In at least one of the control units, linearized versions of the signals are combined for the generation of first and second brake apply command signals for communication to braking actuators. If either control unit does not receive one of the sensor signals from the other, it nevertheless generates its braking actuator control signal on the basis of the sensor signal provided directly to it. In a preferred embodiment of the system, a control unit combines the linearized signals by choosing the largest in magnitude.

Referring again to FIG. 1, the energy storage system 69 stores energy that is used to propel the chassis 10. For most applications, the stored energy will be in chemical form. Examples of energy storage systems 69 include fuel tanks and electric batteries. In the embodiment shown in FIG. 1, the energy storage system 69 includes two compressed gas cylinder storage tanks 121 (5,000 psi, or 350 bars) mounted within the mid-chassis space 41 and configured to store compressed hydrogen gas. Employing more than two compressed gas cylinder storage tanks may be desirable to provide greater hydrogen storage capacity. Instead of compressed gas cylinder storage tanks 121, an alternate form of hydrogen storage may be employed such as metal or chemical hydrides. Hydrogen generation or reforming may also be used.

The energy conversion system 67 converts the energy stored by the energy storage system 69 to mechanical energy that propels the chassis 10. In the preferred embodiment, depicted in FIG. 1, the energy conversion system 67 includes a fuel cell stack 125 located in the rear axle area 18, and an electric traction motor 127 located in the front axle area 16. The fuel cell stack 125 produces a continuously available power of 94 kilowatts. Fuel cell systems for vehicular-use are described in U.S. Pat. No. 6,195,999, issued Mar. 6, 2001 to General Motors Corporation; U.S. Pat. No. 6,223,843, issued May 1, 2001 to General Motors Corporation; U.S. Pat. No. 6,321,145, issued Nov. 20, 2001 to Delphi Technologies, Inc.; and U.S. Pat. No. 6,394,207, issued May 28, 2002 to General Motors Corporation; which are hereby incorporated by reference in their entireties.

The fuel cell stack 125 is operably connected to the compressed gas cylinder storage tanks 121 and to the traction motor 127. The fuel cell stack 125 converts chemical energy in the form of hydrogen from the compressed gas cylinder storage tanks 121 into electrical energy, and the traction motor 127 converts the electrical energy to mechanical energy, and applies the mechanical energy to rotate the front wheels 73, 75. Optionally, the fuel cell stack 125 and traction motor 127 are switched between the front axle area 16 and rear axle area 18. Optionally, the energy conversion system includes an electric battery (not shown) in hybrid combination with the fuel cell to improve chassis acceleration. Other areas provided between the structural elements are useful for housing other mechanisms and systems for providing the functions typical of an automobile as shown in FIGS. 2 and 3. Those skilled in the art will recognize other energy conversion systems 67 that may be employed within the scope of the present invention.

The energy conversion system 67 is configured to respond to non-mechanical control signals. The energy conversion system 67 of the preferred embodiment is controllable by-wire, as depicted in FIG. 10. An energy conversion system control unit 128 is connected to the electrical connector 91 from which it receives electrical energy conversion system control signals 129, and sensors 100 from which it receives sensor signals 101 carrying information about

various chassis conditions. In the preferred embodiment, the information conveyed by the sensor signals 101 to the energy conversion system control unit 128 includes chassis velocity, electrical current applied, rate of acceleration of the chassis, and motor shaft speed to ensure smooth launches and controlled acceleration. The energy conversion system control unit 128 is connected to an energy conversion system actuator 130, and transmits energy conversion system actuator control signals 131 to the energy conversion system actuator 130 in response to the electrical energy conversion system control signals 129 and sensor signals 101 according to a stored algorithm. The energy conversion system actuator 130 acts on the fuel cell stack 125 or traction motor 127 to adjust energy output. Those skilled in the art will recognize the various methods by which the energy conversion system actuator 130 may adjust the energy output of the energy conversion system. For example, a solenoid may alternately open and close a valve that regulates hydrogen flow to the fuel cell stack. Similarly, a compressor that supplies oxygen (from air) to the fuel cell stack may function as an actuator, varying the amount of oxygen supplied to the fuel cell stack in response to signals from the energy conversion system control unit.

An energy conversion system transducer 132 may be located on a vehicle body 85 and connected to a complementary electrical connector 95 engaged with the electrical connector 91. The energy conversion system transducer 132 is configured to convert mechanical energy conversion system control signals 133 to electrical energy conversion system control signals 129.

In another embodiment of the invention, as shown schematically in FIG. 11, wherein like reference numbers refer to like components from FIGS. 6-10, wheel motors 135, also known as wheel hub motors, are positioned at each of the four wheels 73, 75, 77, 79. Optionally, wheel motors 135 may be provided at only the front wheels 73, 75 or only the rear wheels 77, 79. The use of wheel motors 135 reduces the height of the chassis 10 compared to the use of traction motors, and therefore may be desirable for certain uses.

Referring again to FIG. 2, a conventional heat exchanger 137 and electric fan system 139, operably connected to the fuel cell stack 125 to circulate coolant for waste heat rejection, is carried in an opening that exists between the rear axle area 18 and the structural elements 54, 60. The heat exchanger 137 is set at an inclined angle to reduce its vertical profile, but to provide adequate heat rejection it also extends slightly above the top of elements 12, 26 (as seen in FIG. 4). Although the fuel cell stack 125, heat exchanger 137 and electric fan system 139 extend above the structural elements, their protrusion into the body pod space is relatively minor when compared to the engine compartment requirements of a conventionally designed automobile, especially when the chassis height of the preferred embodiment is approximately a mere 15 inches (28 centimeters). Optionally, the heat exchanger 137 is packaged completely within the chassis' structure with airflow routed through channels (not shown).

Referring again to FIG. 1, the suspension system 71 is mounted to the structural frame 11 and is connected to four wheels 73, 75, 77, 79. Those skilled in the art will understand the operation of a suspension system, and recognize that a multitude of suspension system types may be used within the scope of the claimed invention. The suspension system 71 of the preferred embodiment of the invention is electronically controlled, as depicted schematically in FIG. 12.

Referring to FIG. 12, the behavior of the electronically controlled suspension system 71 in response to any given road input is determined by a suspension control unit 141. Sensors 100 located on the chassis 10 monitor various conditions such as vehicle speed, angular wheel velocity, and wheel position relative to the chassis 10. The sensors 100 transmit the sensor signals 101 to the suspension control unit 141. The suspension control unit 141 processes the sensor signals 101 and generates suspension actuator control signals 142 according to a stored algorithm. The suspension control unit 141 transmits the suspension actuator control signals 142 to four suspension actuators 143, 144, 145, 146. Each suspension actuator 143, 144, 145, 146 is operably connected to a wheel 73, 75, 77, 79 and determines, in whole or in part, the position of the wheel 73, 75, 77, 79 relative to the chassis 10. The suspension actuators of the preferred embodiment are variable-force, real time, controllable dampers. The suspension system 71 of the preferred embodiment is also configured such that chassis ride height is adjustable. Separate actuators may be used to vary the chassis ride height.

In the preferred embodiment, the suspension control unit 141 is programmable and connected to the electrical connector 91 of the body-attachment interface 87. A vehicle user is thus able to alter suspension system 71 characteristics by reprogramming the suspension control unit 141 with suspension system software 147 via the electrical connector 91.

In the context of the claimed invention, electronically-controlled suspension systems include suspension systems without a suspension control unit located on the chassis 10. Referring to FIG. 13, wherein like reference numbers are used to reference like components from FIG. 12, suspension actuators 143, 144, 145, 146 and suspension sensors 100 are connected directly to the electrical connector 91. In such an embodiment, a suspension control unit 141' located on an attached vehicle body 85 can process sensor signals 101 transmitted through the electrical connector 91, and transmit suspension actuator control signals 142 to the suspension actuators 143, 144, 145, 146 via the electrical connector 91. Examples of electronically controlled suspension systems are described in U.S. Pat. No. 5,606,503, issued Feb. 25, 1997 to General Motors Corporation; U.S. Pat. No. 5,609,353, issued Mar. 11, 1997 to Ford Motor Company; and U.S. Pat. No. 6,397,134, issued May 28, 2002 to Delphi Technologies, Inc.; which are hereby incorporated by reference in their entireties.

U.S. Pat. No. 6,397,134 describes an electronically controlled suspension system that provides improved suspension control through steering crossover events. In particular, the system senses a vehicle lateral acceleration and a vehicle steering angle and stores, for each direction of sensed vehicle lateral acceleration, first and second sets of enhanced suspension actuator control signals for the suspension actuators of the vehicle. Responsive to the sensed vehicle lateral acceleration and sensed vehicle steering angle, the system applies the first set of enhanced actuator control signals to the suspension actuators if the sensed steering angle is in the same direction as the sensed lateral acceleration and alternatively applies the second set of enhanced actuator control signals to the suspension actuators if the sensed steering angle is in the opposite direction as the sensed lateral acceleration.

U.S. Pat. No. 5,606,503 describes a suspension control system for use in a vehicle including a suspended vehicle body, four unsuspended vehicle wheels, four variable force actuators mounted between the vehicle body and wheels, one of the variable force actuators at each corner of the



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vehicle, and a set of sensors providing sensor signals indicative of motion of the vehicle body, motion of the vehicle wheels, a vehicle speed and an ambient temperature. The suspension control system comprises a microcomputer control unit including: means for receiving the sensor signals; means, responsive to the sensor signals, for determining an actuator demand force for each actuator; means, responsive to the vehicle speed, for determining a first signal indicative of a first command maximum; means, responsive to the ambient temperature, for determining a second signal indicative of a second command maximum; and means for constraining the actuator demand force so that it is no greater than a lesser of the first and second command maximums.

Electrically conductive wires (not shown) are used in the preferred embodiment to transfer signals between the chassis 10 and an attached body 85, and between transducers, control units, and actuators. Those skilled in the art will recognize that other non-mechanical means of sending and receiving signals between a body and a chassis, and between transducers, control units, and actuators may be employed and fall within the scope of the claimed invention. Other non-mechanical means of sending and receiving signals include radio waves and fiber optics.

The by-wire systems are networked in the preferred embodiment, in part to reduce the quantity of dedicated wires connected to the electrical connector 91. A serial communication network is described in U.S. Pat. No. 5,534, 848, issued Jul. 9, 1996 to General Motors Corporation, which is hereby incorporated by reference in its entirety. An example of a networked drive-by-wire system is described in U.S. patent application Publication No. US 2001/0029408, Ser. No. 09/775,143, which is hereby incorporated by reference in its entirety. Those skilled in the art will recognize various networking devices and protocols that may be used within the scope of the claimed invention, such as SAE J1850 and CAN ("Controller Area Network"). A TTP ("Time Triggered Protocol") network is employed in the preferred embodiment of the invention for communications management.

Some of the information collected by the sensors 100, such as chassis velocity, fuel level, and system temperature and pressure, is useful to a vehicle driver for operating the chassis and detecting system malfunctions. As shown in FIG. 14, the sensors 100 are connected to the electrical connector 91 through a chassis computer 153. Sensor signals 101 carrying information are transmitted from the sensors 100 to the chassis computer 153, which processes the sensor signals 101 according to a stored algorithm. The chassis computer 153 transmits the sensor signals 101 to the electrical connector 91 when, according to the stored algorithm, the sensor information is useful to the vehicle driver. For example, a sensor signal 101 carrying temperature information is transmitted to the electrical connector 91 by the chassis computer 153 when the operating temperature of the chassis 10 is unacceptably high. A driver-readable information interface 155 may be attached to a complementary electrical connector 95 coupled with the electrical connector 91 and display the information contained in the sensor signals 101. Driver-readable information interfaces include, but are not limited to, gauges, meters, LED displays, and LCD displays. The chassis may also contain communications systems, such as antennas and telematics systems, that are operably connected to an electrical connector in the body-attachment interface and configured to transmit information to an attached vehicle body.

One control unit may serve multiple functions. For example, as shown in FIG. 15, a master control unit 159

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functions as the steering control unit, braking control unit, suspension control unit, and energy conversion system control unit.

Referring again to FIG. 15, the energy conversion system 67 is configured to transmit electrical energy to the electrical connector 91 to provide electric power for systems located on an attached vehicle body, such as power windows, power locks, entertainment systems, heating, ventilating, and air conditioning systems, etc. Optionally, if the energy storage system 69 includes a battery, then the battery may be connected to the electrical connector 91. In the preferred embodiment, the energy conversion system 67 includes a fuel cell stack that generates electrical energy and is connected to the electrical connector 91.

FIG. 16 shows a chassis 10 with rigid covering, or "skin," 161 and an electrical connector or coupling 91 that functions as an umbilical port. The rigid covering 161 may be configured to function as a vehicle floor, which is useful if an attached vehicle body 85 does not have a lower surface. In FIG. 17 a similarly equipped chassis 10 is shown with an optional vertical fuel cell stack 125. The vertical fuel cell stack 125 protrudes significantly into the body pod space which is acceptable for some applications. The chassis 10 also includes a manual parking brake interface 162 that may be necessary for certain applications and therefore is also optionally used with other embodiments.

FIG. 18 depicts an embodiment of the invention that may be advantageous in some circumstances. The energy conversion system 67 includes an internal combustion engine 167 with horizontally-opposed cylinders, and a transmission 169. The energy storage system 69 includes a gasoline tank 171.

FIG. 19 depicts an embodiment of the invention wherein the steering system 81 has mechanical control linkages including a steering column 173. Passenger seating attachment couplings 175 are present on the body attachment interface 87, allowing the attachment of passenger seating assemblies to the chassis 10.

FIGS. 20 and 20a depict a chassis 10 within the scope of the invention and a body 85 each having multiple electrical connectors 91 and multiple complementary electrical connectors 95, respectively. For example, a first electrical connector 91 may be operably connected to the steering system and function as a control signal receiver. A second electrical connector 91 may be operably connected to the braking system and function as a control signal receiver. A third electrical connector 91 may be operably connected to the energy conversion system and function as a control signal receiver. A fourth electrical connector 91 may be operably connected to the energy conversion system and function as an electrical power connector. Four multiple wire in-line connectors and complementary connectors are used in the embodiment shown in FIGS. 20 and 20a. FIG. 20a depicts an assembly process for attaching corresponding connectors 91, 95.

Referring to FIG. 21, a further embodiment of the claimed invention is depicted. The chassis 10 has a rigid covering 161 and a plurality of passenger seating attachment couplings 175. A driver-operable control input device 177 containing a steering transducer, a braking transducer, and an energy conversion system transducer, is operably connected to the steering system, braking system, and energy conversion system by wires 179 and movable to different attachment points.

The embodiment depicted in FIG. 21 enables bodies of varying designs and configurations to mate with a common chassis design. A vehicle body without a lower surface but

having complementary attachment couplings is matable to the chassis 10 at the load-bearing body retention couplings 89. Passenger seating assemblies may be attached at passenger seating attachment couplings 175.

FIG. 22 illustrates a range of bodies or body pods 211-214 that may be employed on a single chassis or rolling platform 215. The owner of the rolling platform 215 can adapt to seasonal changes or lifestyle changes by simply changing vehicle body pods. The rolling platform includes most of the durable hardware, meaning body pods require far less material and energy to produce than complete vehicles.

Referring to FIG. 23, the process of securing optional bodies or body pods is depicted. Body pods (a.k.a. 'bodies') can be hot swapped on a random time interval basis according to the whim of the driver or on a scheduled basis according to the guidelines of the vehicle pod provider. This aspect provides a business model of how a vehicle body can be rented, leased, exchanged, or sold. Accordingly, the driver may be an owner, renter or lessee. The process of vehicle body interchangeability provides that the consumer can disconnect and connect vehicle bodies quickly without headaches of complexity. Just lift off and drop pods with mechanical and electrical common interface connections as described previously. Initially, the driver secures the use of a rolling chassis 241 and a body pod 242. A body pod service provider 245 maintains an inventory of body pods 246 that are either available on site, ordered to specification, or in use by other drivers and rotated among a group of drivers according to schedule. Each body pod carries a chip that communicates parameters to the rolling chassis to set fuel cell performance to match the body pod, adjusts suspension performance, adjusts steering performance and communicates other specifications.

The manufacture of chassis or rolling platform and body pods is depicted in FIG. 24. In the conventional manufacturing processes, the automobile is manufactured as a single unitary system. According to the present invention, the rolling platform system is manufactured independently of the vehicle body pods. The rolling platform, which contains a majority of the technological and mechanical content, is exported from central manufacturing locations to any location around the world. The vehicle bodies are manufactured in the same central locations or in local environments incorporating local materials and matched to the needs of the local market.

Engineering of the rolling platform enables the vehicle body to be designed and produced independently. Bodies are manufactured and designed substantially independently anywhere in the world to meet different consumer desires. Local manufacturers, using locally available materials, can build vehicle bodies according to local tastes. Without a coupled body, the rolling platform manufacturing process is streamlined for production at key manufacturing sites around the world for exportation to points of purchase. Designers have the ability to redesign vehicle bodies without reengineering the entire vehicle.

According to the embodiment shown in FIG. 24, a factory 250 manufactures body pods (a.k.a. bodies) according to a plurality of designs 251-253. The body pods are complete, or essentially complete, ready to be interconnected with a rolling chassis. All body pod styles 251-253 are designed to be connected to a rolling chassis having common connection points. A second factory 255 which can be located remote from the factory 250, or can be the same factory, produces rolling chassis 256. The rolling chassis 256 each have common connection points for connecting to a plurality of body pods.

Turning to FIG. 25, a business process model is illustrated wherein an owner secures a rolling chassis 220 for x years by means such as a purchase, with or without financing, or under a lease. The rolling chassis may be mortgaged for 20 years, for example, wherein the expense is spread out over the expected reasonable serviceability life of the unit. The terms of the transaction include certain software upgrades 221 and hardware/software upgrades 222 that are provided without additional charge and other upgrades 223 that are secured by the owner/lessee (driver) at their option and at additional cost. At the end of the 20 year span (or other term), the rolling chassis may be owned with no security obligation remaining to the original financing entity.

During the life of the rolling chassis, the driver uses the vehicle according to their changing tastes or needs. For example, a scenario wherein a driver starts with a small, sporty body pod 226, advances to a utilitarian type body pod 228, then to a sport-utility type body pod 230, a van type body pod 232 and onto a station wagon type body pod 234 is possible. Of course, the type of body pods chosen and the time to change is completely at the discretion of the driver.

FIGS. 26-28 illustrate various types of financial transactions or business methods which are available as a result of the unique chassis and interface system of the invention. The financial transactions and business methods shown are merely exemplary. A wide variety of different types of financial transactions and business methods are enabled by the present invention, and selected business steps described may be performed alone or in combination with other selected business steps from various embodiments of the invention by different business entities. The examples described are not intended to be limiting, but rather illustrate a sampling of possible business arrangements to exploit the rolling platform and interface system.

FIG. 26 illustrates a method of conducting a vehicle business transaction 280, wherein a chassis is either manufactured or purchased (steps 282 or 284). Possession of the chassis is offered to a customer in a financial transaction (step 286). The chassis may be leased (step 288) or financed (step 290) in exchange for a security interest in the chassis.

As part of the financing arrangements, repayment durations may exceed 10, 15, or 19 years, or include a balloon payment (step 292).

Independently of steps 282-292 described above, a vehicle body may be manufactured or purchased (steps 294 or 296). Possession of the body is then offered to the customer in a financial transaction (step 298). The body may be rented or leased (step 300) or financed in exchange for a security interest in the body (step 302). Steps 294-302 may occur before, simultaneously with, or after steps 282-292. The financial transaction for the chassis may then be reduced to a chassis contract (step 304), or the financial transactions for the body and chassis may be incorporated into a single contract (step 306). Similarly, the financial transaction for the body may be reduced to a body contract (step 308), or incorporated into the single contract for the chassis and body (step 306). The body and chassis may be priced separately or together.

If the financial transaction for the chassis is reduced to the chassis contract (step 304) then possession of the chassis may be granted (step 310), or the chassis may be attached to a body prior to granting possession (step 312). Similarly, if the financial transaction for the body is reduced to the body contract (step 308), then possession of the body may be granted (step 314), or the body may be attached to the chassis prior to granting possession (step 312).

After possession of the chassis and/or body is granted, scheduled hardware and/or software updates may be provided over the life of the chassis and/or body (step 316).

By way of example, another method of conducting a vehicle business transaction 330 is illustrated in FIG. 27. As shown, the chassis are either manufactured or purchased (steps 332 or 334). Possession of the chassis is offered, wherein the chassis include a frame, suspension, wheels, fuel cell, drive-by-wire, and a standardized body/chassis interface system (step 336). Leasing and financing options are offered for the chassis (steps 338 and 340). Independently, before, after, or concurrently with steps 332-340, vehicle bodies are either manufactured or purchased (step 342 or 344). A body inventory is maintained, wherein each body includes the same standardized body/chassis interface system as the chassis (step 346). By way of example, the body inventory may include sedans, pick-up trucks, vans, sport-utility vehicles, convertibles, coupes, station wagons, mini-vans, and/or trucks. The customer is offered a selection of bodies from the inventory (step 348). Leasing, renting and financing options are offered on the body (steps 350 and 352).

Independently from the body, a chassis contract may be executed with a customer (step 354). The chassis contract may include financing, leasing or renting terms having a duration in excess of 10, 15 or 20 years. Similarly, independently from the chassis, a body contract may be executed with a customer (step 356). The body contract may also include financing or leasing terms. The leasing or renting term may be relatively short, such as 6 months or 1 year.

Alternatively, a single contract may be executed embodying the financial transactions for both the body and the chassis (step 358). If a chassis contract is executed independently of the body (step 354), then possession of the chassis may be granted in the associated financial transaction 360. Similarly, if a body contract is executed independently of the chassis, then possession of the body may be granted in the associated financial transaction 362. Finally, if a body/chassis contract is executed (step 358), then the body may be attached to the chassis, and possession of the vehicle may be granted in the associated financial transaction thereafter (step 362).

A further method of conducting a vehicle business transaction 380 is illustrated in FIG. 28. As illustrated, possession of a chassis may be granted, wherein the chassis conforms to the standardized body/chassis interface (step 382). The chassis may be financed for a period of time (x), which may exceed 10, 15, or 19 years (step 384). Independently, before, after, or concurrently with steps 382 and 384, possession of a body conforming to the standardized body/chassis interface system may be granted (step 386). Optionally, the body may be financed for a period of time (y) (step 388), which is different than the period of time (x).

Thereafter, the body may be attached to the chassis (step 390), and/or programs on the chassis computer or body computer may be updated, added, modified, or deleted (steps 392 or 394). The updates and modifications may be included, or may be provided at additional cost. As part of the financing arrangement, new components may be installed to the chassis or body over the life of the chassis or body (steps 396 or 398).

According to another aspect of the invention, interior components of the body may be individually rented, leased, exchanged or sold separately from the body structure (step 400). For example, seats, consoles, electronic equipment, etc. may be acquired separately from the body structure and later exchanged to alter the vehicle interior. Further, body

closures, such as door panels, hood panels, hatchback doors, etc. may be acquired individually and later exchanged to alter the vehicle exterior.

Also, as set forth in the claims, various features from the different embodiments of the invention illustrated may be combined within the scope of the present invention.

While the best modes for carrying out the invention have been described in detail, those familiar with the art to which this invention relates will recognize various alternative designs and embodiments for practicing the scope of the invention within the scope of the appended claims.

The invention claimed is:

1. A method of conducting a vehicle business transaction with a customer, comprising:

granting possession of a common vehicle chassis having a standardized body-attachment interface to the customer in a first financial transaction for consideration; and

granting possession of an interchangeable vehicle body to the customer in a second financial transaction for consideration independently of the common vehicle chassis, the interchangeable vehicle body selected from a maintained inventory of interchangeable vehicle bodies each having a common base with a standardized chassis attachment interface that is mateable with the standardized body-attachment interface of the common chassis.

2. The method of claim 1, wherein the customer is an end-user of the vehicle.

3. The method of claim 1, wherein the second financial transaction is a lease or rental agreement having a term less than or equal to one year.

4. The method of claim 1, wherein said step of granting possession of the chassis comprises leasing.

5. The method of claim 1, wherein said first and second financial transactions are defined by a single contract establishing different terms for the chassis and body.

6. The method of claim 1, wherein the common chassis comprises:

a structural frame having a first rail; a second rail spaced a distance apart from the first rail and cooperating with the first rail to at least partially define a protected cavity; a third rail outboard of the first rail and cooperating with the first rail to at least partially define a first lateral cavity outboard of the protected cavity; a fourth rail outboard of the second rail and cooperating with the second rail to at least partially define a second lateral cavity outboard of the protected cavity; said first and second rails extending forward of said third and fourth rails;

a suspension system mounted with respect to the structural frame;

at least three wheels rotatably mounted with respect to the suspension system;

an energy conversion system mounted with respect to the structural frame, operably connected to at least one wheel, an controllable by wire; and

a by-wire braking system mounted with respect to the frame and operably connected to at least one wheel;

wherein said standardized body-attachment interface has a plurality of body connection components including at least one load bearing body-retention coupling and at least one control signal receiving electrical connector; and wherein said standardized body-attachment interface is mateable with said standardized chassis attachment interface to enable each of said bodies in said

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maintained inventory to be quickly disconnected from and connected to said common chassis.

7. A method of conducting a vehicle business transaction with a customer, comprising:

granting possession of a vehicle chassis to the customer in a first financial transaction for consideration, wherein the chassis comprises:

a structural frame; a suspension system mounted with respect to the structural frame; at least three wheels rotatably mounted with respect to the suspension system; an energy conversion system mounted with respect to the structural frame, operably connected to at least one wheel, and controllable by wire; a by-wire steering system mounted with respect to the frame and operably connected to at least one wheel; a by-wire braking system mounted with respect to the frame and operably connected to at least one wheel; and a stan-

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dardized body attachment interface having a plurality of body connection components, the body connection components including at least one load bearing body-retention coupling and at least one control signal receiving electrical connector; and

granting possession of an interchangeable vehicle body to the customer in a second financial transaction for consideration independently of the vehicle chassis, the interchangeable vehicle body selected from a maintained inventory of interchangeable vehicle bodies each having a common base with a standardized chassis attachment interface that is engageable with the standardized body attachment interface of the common chassis.

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